Circularising Organics

ISBN 978-1-99-117171-9

waikatoregion.govt.nz

Authors/contributors


Valerie Bianchi
Waikato Regional Council


Upananda Paragahawewa
Waikato Regional Council


Chris Purchas
Tonkin + Taylor


Anna Ainsworth
Tonkin + Taylor


Soph Brockbank
Tonkin + Taylor


Raquelle de Vine
Tonkin + Taylor


Ben Riordan
Formally Tonkin + Taylor - now Foodstuffs


Zoe Yandell
Tonkin + Taylor


Hannah Kelly
Tonkin + Taylor


Natasza Letowt-Vorbek
Tonkin + Taylor

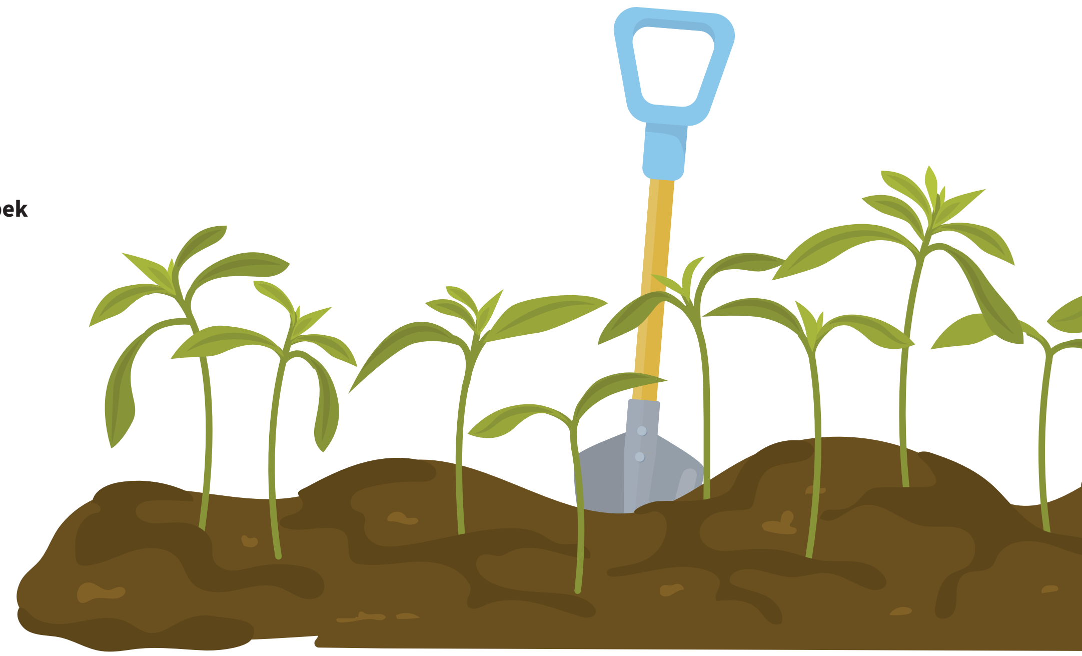

Amy Whetu
Whetū Consultancy Group


Tamoko Ormsby
Whetū Consultancy Group


Rachel Glasier
Envision


Sunshine Yates
Sunshine Yates Consulting


Liam Prince
The Rubbish Trip



Acknowledgments

Thank you for the financial support for this project, which has been received from the Waste Minimisation Fund, which is administered by the Ministry for the Environment.

The Ministry for the Environment does not necessarily endorse or support the content of the publication in any way .

Thank you also for the financial support received from the Waikato Wellbeing Project.

This report was peer reviewed between October 2023 and March 2024 and approved for release by Dean King in April 2024.

Executive summary

Historically, cycling organic material back into the soil was a commonplace practice for both Māori and Pākehā until the latter half of the 20th century (Diprose et al 2023a). However, in our current linear system, approximately half of what is wasted to landfill in the Waikato region is organic material (Eve et al 2021). This represents a waste of resources and a source of pollution. For example, for every tonne of food sent to landfill, a third of a tonne of CO_2 equivalent greenhouse gasses is generated.

There are many organisations and people working to reduce organic material going to waste. For example:

- The Love Food Hate Waste programme supports people to reduce food scraps so they don't become waste.
- Organisations, such as Go Eco Food Rescue, rescue edible food and redistribute it to people in need.
- Para Kore Marae Incorporated and Enviroschools support the use of on-site worm bins and compost systems at marae and schools.
- Community composting throughout our region helps build relationships and enable local food to be grown.
- Pioneering businesses have established circular systems converting agricultural and horticultural 'waste' into vermi/compost or energy.
- Ahead of legislative requirements, some territorial authorities have already rolled out kerbside organic material collections under their own Waste Minimisation and Management Plans (WMMPs).

In addition to these actions, Central government is implementing mandatory roll out of kerbside organic material collection for businesses and urban settlements of 1000 people or more between 2027 and 2030. While it is clear organic material will need to be collected, how this material will be processed and turned into a high quality, contaminant free product is not. Understanding these details and their implications is crucial, as decisions and investment made now will affect New Zealand's organics management system for decades to come (Diprose et al. 2023b).

The Circularising Organics (CO) was coordinated by the Waikato Regional Council and carried out by a team of researchers. The CO project aims to assist in decision making to develop a robust organic material system. CO research set out to investigate the implications of different types and methods of collections and processing organic material, contamination and how this might be mitigated, and identify what end markets already exist for a high-quality product. The project draws on circular economy principles to design waste and pollution out; keep products and materials in use for as long as possible; and regenerate nature via creating small closed system loops (Ellen McArthur Foundation n.d.). To add to this, circular economy should also aim to increase social and cultural equity (Bianchi and Yates 2022). Drawing on these principles, the CO project contributes to the development of robust and resilient organics material systems that improve soil health, reduces emissions, feeds families, creates jobs and increases mana.

Networks and collaboration are key elements of a circular economy as this systemic transformation cannot be achieved through isolated actions. There is an opportunity for local government to work together and with key stakeholders to develop a network approach. This approach allows organic material to be processed at a variety of sites which create local resource loops, adding resilience and variability to the system as a whole. This approach also allows for consideration on how community and iwi might be supported to engage in and benefit from organic material management opportunities. Applied to an organic material management system, a network approach will add resilience through adding to the overall system's processing capacity. This avoids an overreliance on only one or two large facilities, which can create vulnerabilities.

Building local capability in organic material processing, including at the iwi and marae levels, can contribute to community resilience, economic growth and environmental sustainability. Community scale organics material processing as close as possible to source has the potential to connect people to place and boost local food production. In order for Māori communities to engage effectively in organics material management, iwi/Māori organisations should be supported through the development of a business plan that connects organics material processing benefits to other priorities, and that demonstrates how an economically sustainable system can operate. Community

organisations can also benefit from business plans that include consideration for operational funding as this has been a barrier in the past. Business plans for iwi/Māori and community should be used to identify training opportunities increase local expertise and career pathways.

In a circular economy there are both biological and technical loops. The only materials that are suitable to cycle through the biological loop are those that can regenerate nature when returned to the Earth (Ellen McArthur Foundation 2019). One of the main issues in transitioning to a circular economy is ensuring products in the technical cycle are regulated and updated to as to not undermine the regenerative potential of the biological loop. Ideally the materials cycling through the technical cycle remain isolated through better design, repairability, remanufacture and reuse, as well as complimentary regulation to reduce toxicity and waste (Ellen McArthur Foundation 2019).
However, products from the technical cycle are currently leaking into the biological cycle as contamination. This includes physical contamination, such as plastic, as well as chemical contamination, such as PFAS and broadleaf herbicides. Contamination threatens our ability to secure a safe, healthy organic material cycle and food production. Physical and chemical contamination also effects the economic value of a possible end product. Contamination needs to be addressed at every stage: for example with policy that regulates pollution, engagement with system users so contamination does not enter the system, and with methods to remove contamination at the processing level. We all have a role to play in establishing a robust organic material management system.

Find out more through the following reports or tools that have been prepared as part of this project:

Whakapapa centred transition

This report discusses the potential of maatauranga Māori to inform decision-making in the Circularising Organics Project. The report and subsequent discussions were used by the project team to inform other areas of research. Whakapapa is the fundamental concept that guides this approach toward "culturally-appropriate" decision-making in organics processing.

Situational overview

This report includes information and data to support decision making. This includes an overview of existing regulations and policy that relates to organic material. An overview of organic material recovery approaches and kerbside delivery/hardware options is provided. Data in the Waikato is given, including organic material generation, existing collection services and processing facilities.

Product end markets are covered with emphasis on industry markets, including horticultural demand. Finally, a review of regional barriers and opportunities is provided.

Localising Organics

This report provides consideration of how a regionally coordinated approach to collecting and processing organics at the home, neighbourhood, suburb, town, city and regional levels may function side-by-side and complement each other to achieve a range of positive outcomes. It explores the benefits and opportunities for multiple systems to work together.

Literature review on contamination

This paper discusses the issue of contamination of organic materials destined for processing into valuable soil additives and fertiliser products (e.g. via composting, anaerobic digestion). After defining contamination and highlighting key problems and risks, including the impacts of contamination from a Te Ao Māori perspective, the document then identifies and discusses effective ways to prevent, reduce and manage contamination.

Opportunities for community

The focus of this study is to understand what role community organisations in the Waikato want to play in the collection and processing of organics and how they can be enabled to do more

Exploring Te Ao Māori perspectives and market opportunities

Explores culturally appropriate decision-making considerations and opportunities for iwi, Māori and community. With data support from other areas of the project, the purpose of this report is to generate a study on the potential business/employment opportunities for iwi/Māori business.

Decision making tool

An online tool to support collections and processing decision making.

References

Bianchi V, Yates S 2022. The journey to a circular economy in the Waikato Region. Hamilton: Waikato Regional Council. TR 2021/34.

Diprose G, Dombroski K, Sharp E, Yates A, Peryman B, and Barnes M 2023a. Emerging transitions in organic waste infrastructure in Aotearoa New Zealand. New Zealand Geographer, 79(1), 15– 26. https://doi.org/10.1111/nzg.12348

Diprose G, Levenson E, Booth P, Prince L, and Blumhardt H 2023b. Scaling-up, scaling-out & branching-out: Understanding & procuring diverse organic materials management models in Aotearoa New Zealand. [report] Manaaki Whenua Landcare Research. https://www.landcareresearch.co.nz/news/revolutionising-organic-waste-infrastructure/

Eve L, van Gool E, Wilson D, Middleton B, and Yates S 2022. Waikato and Bay of Plenty region waste and recycling stocktake 2021. Hamilton: Waikato Regional Council. TR 2022/11.

Ellen MacArthur Foundation. N.d. What is a circular economy? [accessed 2023 November 28] https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

Ellen MacArthur Foundation 2019. Circular economy systems diagram. https://www.ellenmacarthurfoundation.org/circular-economy-diagram

Executive summary

for people working in local government

In our current linear system, approximately half of what is wasted to landfill in the Waikato region is organic material (Eve et al 2021). This represents a waste of resources and a source of pollution. For example, for every tonne of food sent to landfill, a third of a tonne of CO_2 equivalent greenhouse gasses is generated.

Organic material diversion should be a priority for all tiers of government, as indicated by the Emissions Reduction Plan 2022, Te rautaki para | Waste strategy 2023, and the mandatory roll-out of kerbside organic material collections scheduled to occur between 2027 and 2030. While it is clear organic material will need to be diverted to help meet waste and climate emissions objectives and mandates, how this material will be collected, processed and turned into a high quality, contaminant free product is not. Decisions and investment made now will affect New Zealand's organics management system for decades to come (Diprose et al. 2023).

The Circularising Organics (CO) project aims to assist in decision making to develop a robust organic material system. CO research set out to investigate the implications of different types and methods of collections and processing organic material, contamination and how this might be mitigated, and identify what end markets already exist for a high-quality product. The project draws on circular economy principles to design waste and pollution out; keep products and materials in use for as long as possible; and regenerate nature via creating small closed system loops (Ellen McArthur Foundation n.d.). To add to this, circular economy should also aim to increase social and cultural equity (Bianchi and Yates 2022). Drawing on these principles, the CO project contributes to the development of robust and resilient organics material systems that improve soil health, reduces emissions, feeds families, creates jobs and increases mana.

Local coordination of resource recovery has been highlighted as a way local government can support the transition to a circular economy (MfE 2022b; MfE 2023b). Networks and collaboration are key elements of a circular economy as this systemic transformation cannot be achieved through isolated actions. There is an opportunity for local government to work together and with key stakeholders to develop a network approach. This approach allows organic material to be processed at a variety of sites which create local resource loops, adding resilience and variability to the system as a whole. This approach also allows for consideration on how community and iwi might be supported to engage in and benefit from organic material management opportunities. Applied to an organic material management system, a network approach will add resilience through adding to the overall system's processing capacity. This avoids an overreliance on only one or two large facilities, which can create vulnerabilities.

Building local capability in organic material processing, including at the iwi and marae levels, can contribute to community resilience, economic growth and environmental sustainability. Community scale organics material processing as close as possible to source has the potential to connect people to place and boost local food production. In order for Māori communities to engage effectively in organics material management, iwi/Māori organisations should be supported through the development of a business plan that connects organics material processing benefits to other priorities, and that demonstrates how an economically sustainable system can operate. Community organisations can also benefit from business plans that include consideration for operational funding as this has been a barrier in the past. Business plans for iwi/Māori and community should be used to identify training opportunities increase local expertise and career pathways.

In a circular economy there are both biological and technical loops. The only materials that are suitable to cycle through the biological loop are those that can regenerate nature when returned to the Earth (Ellen McArthur Foundation 2019). One of the main issues in transitioning to a circular economy is ensuring products in the technical cycle are regulated and updated to as to not undermine the regenerative potential of the biological loop. Ideally the materials cycling through the technical cycle remain isolated through better design, repairability, remanufacture and reuse, as well as complimentary regulation to reduce toxicity and waste (Ellen McArthur Foundation 2019).

However, products from the technical cycle are currently leaking into the biological cycle as contamination. This includes physical contamination, such as plastic, as well as chemical contamination, such as PFAS and broadleaf herbicides. Contamination threatens our ability to secure a safe, healthy organic material cycle as well as influences the economic value of an end product. Contamination needs to be addressed at every stage: for example with policy that regulates pollution, communication and engagement with system users so contamination does not enter the system, and mitigation at the system level.

The CO project has been coordinated by Waikato Regional Council and carried out by a team of researchers. Researchers fulfilled their own area of study based on their expertise while meeting regularly to share findings and identify common themes. Find out more through the following reports or tools that have been prepared as part of this project:

Whakapapa centred transition

This report discusses the potential of maatauranga Māori to inform decision-making in the Circularising Organics Project. The report and subsequent discussions were used by the project team to inform other areas of research. Whakapapa is the fundamental concept that guides this approach toward "culturally-appropriate" decision-making in organics processing.

Situational overview

This report includes information and data to support decision making. This includes an overview of existing regulations and policy that relates to organic material. An overview of organic material recovery approaches and kerbside delivery/hardware options is provided. Data in the Waikato is given, including organic material generation, existing collection services and processing facilities.

Product end markets are covered with emphasis on industry markets, including horticultural demand. Finally, a review of regional barriers and opportunities is provided.

Localising Organics

This report provides consideration of how a regionally coordinated approach to collecting and processing organics at the home, neighbourhood, suburb, town, city and regional levels may function side-by-side and complement each other to achieve a range of positive outcomes. It explores the benefits and opportunities for multiple systems to work together.

Literature review on contamination

This paper discusses the issue of contamination of organic materials destined for processing into valuable soil additives and fertiliser products (e.g. via composting, anaerobic digestion). After defining contamination and highlighting key problems and risks, including the impacts of contamination from a Te Ao Māori perspective, the document then identifies and discusses effective ways to prevent, reduce and manage contamination.

Opportunities for community

The focus of this study is to understand what role community organisations in the Waikato want to play in the collection and processing of organics and how they can be enabled to do more.

Exploring Te Ao Māori perspectives and market opportunities

Explores culturally appropriate decision-making considerations and opportunities for iwi, Māori and community. With data support from other areas of the project, the purpose of this report is to generate a study on the potential business/employment opportunities for iwi/ Māori business.

Decision making tool

An online tool to support collections and processing decision making.

References

Bianchi V, Yates S 2022. The journey to a circular economy in the Waikato Region. Hamilton: Waikato Regional Council. TR 2021/34.

Diprose G, Levenson E, Booth P, Prince L, and Blumhardt H 2023b. Scaling-up, scaling-out & branching-out: Understanding & procuring diverse organic materials management models in Aotearoa New Zealand. [report] Manaaki Whenua Landcare Research. https://www.landcareresearch.co.nz/news/revolutionising-organic-waste-infrastructure/

Ellen MacArthur Foundation. N.d. What is a circular economy? [accessed 2023 November 28] https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

Ellen MacArthur Foundation 2019. Circular economy systems diagram. https://www.ellenmacarthurfoundation.org/circular-economy-diagram

Eve L, van Gool E, Wilson D, Middleton B, and Yates S 2022. Waikato and Bay of Plenty region waste and recycling stocktake 2021. Hamilton: Waikato Regional Council. TR 2022/11.

Waikato Regional Council (WRC) 2020. Waikato Regional Waste Prevention Action Plan 2020-2025. Hamilton: Waikato Regional Council.

Main contents pages

Introduction

Valerie Bianchi
Waikato Regional Council

February 2024

Waikato
REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

Introduces the project and discusses this in the context of circular economy, Te Tiriti o Waitangi, Waikato Wellbeing Sustainable Development goal 12, and the waste hierarchy.

Introduction

The Waikato and Bay of Plenty Regional Waste Stocktake (Eve et al 2022) shows that organic material comprises 48% of kerbside rubbish destined for landfill. For every tonne of organic material sent to landfill, a third of a tonne of CO_2 equivalent greenhouse gasses will be generated. Food scraps alone make up 22% of landfill emissions (MfE 2022a). However, with thoughtful consideration and planning, we have an opportunity to redesign our system so that it supports wellbeing for both people and environment.

Organisations across Aotearoa, including throughout the Waikato region, are already working within their spheres of influence to put organic material to a better use while avoiding landfill.

- The Love Food Hate Waste programme supports people to reduce food scraps so they don't become waste.
- Organisations, such as Go Eco Food Rescue, rescue edible food and redistribute it to people in need.
- Para Kore Marae Incorporated and Enviroschools support the use of on-site worm bins and compost systems.
- Community composting throughout our region helps build relationships and enable local food to be grown.
- Pioneering businesses have established circular systems converting agricultural and horticultural 'waste' into vermi/compost or energy.
- Ahead of legislative requirements, some territorial authorities have already rolled out kerbside organic material collections under their own Waste Minimisation and Management Plans (WMMPs).

Central government contributes national direction and has indicated through the Emissions Reduction Plan 2022 and Te rautaki para | Waste strategy 2023 that Aotearoa New Zealand will have a low waste, low emissions circular economy by 2050 (MfE 2022b; MfE 2023b). Local government, including regional councils, hold a key role in enabling this transition (MfE 2022b; MfE 2023b). This includes fulfilling the mandate that all urban areas of 1000 people or more, as well as businesses, have access to kerbside organics material collections by 2027 or 2030 (MfE 2023c).

Waikato Regional Council contributes to waste prevention through the *Waste Prevention Action Plan 2020-2025* (WRC 2020). This plan provides the Council with focus and action areas, including providing local coordination and aiding resource recovery, which have been highlighted as ways local government can support the transition to a circular economy (MfE 2022b; MfE 2023b). As part of this action plan, the study *The journey to a circular economy in the Waikato region* (Bianchi and Yates 2022) was undertaken to see how local government might develop understanding of circular economy principles. As part of this research, our territorial authority partners were engaged to assess their level of interest in potential pilot or research projects. This showed that further investigation into organic material processing was one of our local government partners' highest priorities. In alignment with the objectives of the *Waste Prevention Action Plan* (WRC 2021) and the research findings from *The journey to a circular economy in the Waikato region* (Bianchi and Yates 2022), the Circularising Organics (CO) project was developed.

Under the Local Government Act 2002, a local authority (regional council or territorial authority) must have regard to the contribution that solid waste collection and disposal makes to its communities. Regional councils also have responsibilities under the Resource Management Act 1991 to achieve integrated management of the region's natural and physical resources and to regulate discharge of contaminants into the environment. The waste we generate and how we manage that waste has an influence on our natural resources. Preventing waste and establishing robust systems that elevate 'waste' to a resource will reduce discharge of contaminants into the environment and enable regional council to fulfil these mandates. To meet additional legislative requirements toward waste management and align with the waste hierarchy (discussed in the Introduction below), local government should enable the development of a highly functioning organics material management system while supporting source prevention and on-site management of organic material.

The CO project had three areas of focus:

Collections and processing options

Each community should apply the appropriate collections and processing approach to their local area. However, there is an opportunity to share the same baseline information on collections and processing to facilitate decision making, cross boundary partnerships and infrastructure without replication of research and data gathering.

Contamination and its mitigation

Contamination, including physical and chemical contaminants, should be mitigated, or eliminated for human and environmental health. Contamination has an influence on overall system performance, including marketability of a product and the extent to which an organic material system upholds or undermines core circular economy goals (e.g. regenerating nature and designing out pollution).

Potential end product markets

In a high functioning system, contaminant free organic material can be collected and processed to form a quality product with a clear end market to close the loop while supporting wider co-benefits such as soil health and sustainable food production.

The CO project has been coordinated by Waikato Regional Council and carried out by a team of researchers. Researchers fulfilled their own area of study based on their expertise while meeting regularly to share findings and identify common themes.

The CO project focuses on the **organic material management** of organic material waste (also referred to as organic waste, or ‘organics’). Organic material/ waste can include food loss and waste (MfE 2023a) from both residential and industrial sources (such as dairy or horticulture), green waste (such as lawn clippings, barks or wood), biosolids,

Circular Economy

At the core of the circular economy is the need to shift from the current linear take-make-dispose system. There is a common misconception that this transition means improving waste management through turning current waste into a value-added product (Blumhardt 2023). However, the principles of the circular economy are to design waste, pollution and emissions out at the source by redesigning how we produce and consume (Bumhardt 2023). Products and materials are kept in use for as long as possible, for example by being built to last, repaired or rebuilt. There is a reduction on resource extraction so less damage is committed to the environment. Natural systems are regenerated through both a reduction of damage and positive contribution, for example through composting soils (Blumhardt 2023; Ellen McArthur Foundation n.d.).

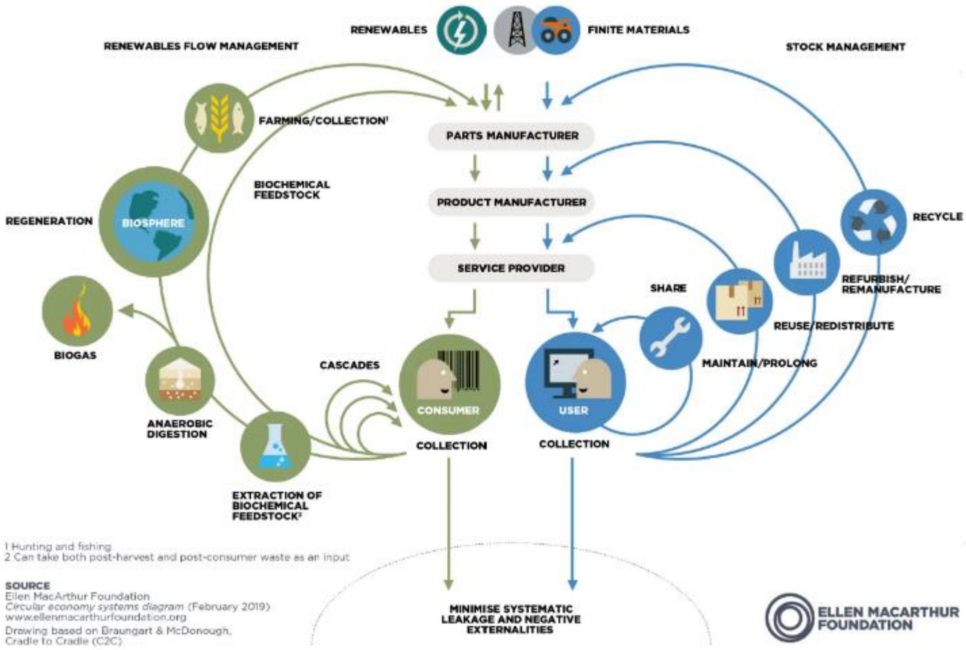


Figure 1 Circular economy butterfly diagram (EMF 2019)

The circular economy has both biological and technical loops that should remain separate to retain the integrity of biological cycles and ensure there is a thriving bioeconomy. The bioeconomy and the biological loop of the circular economy butterfly diagram refer to the parts of the economy that feature the use of organic material or renewable biological resources (MfE 2022b). As part of a circular (bio) economy, organic material is returned to the soil to enhance natural systems (MfE 2023b). The circular economy should be made up of small, closed loops, where biological material remains free from contamination. This can be actualised by regulation and better design to keep products in the technical cycle from leaking into the environment. In our current system, material from the technical cycle are released into the environment as waste and pollution. Organic material contamination from the technical cycle include physical contamination, like plastics, and chemical contamination, such as PFAS and herbicides. In order to address this in the organic material cycle, these types of contamination need to be considered at their systemic origins.

Circular economy is a broad concept that acts as a guide for practical use. Local application of trials and tests should be conducted as part of a reflective practice that will enable robust development of a circular economy. Through this process, collaboration and strong relationships should be developed as these are essential to successful transition to a resource smart circular economy (Bianchi and Yates 2022).

Figure 2 Principles of a circular economy (Bianchi and Yates 2022)

A robust circular economy works within planetary limits via closed loops that include social responsibility (Johansson and Henriksson 2020). Therefore, increasing social and cultural equity should be included as a fundamental circular economy principle (Bianchi and Yates 2022). In the context of a circular bioeconomy, the development of an organic material management system should consider the opportunity for social procurement and how to build community wealth. The development of organic material management systems in Aotearoa New Zealand need to include how Te Tiriti obligations and support for tino rangatiratanga will be fulfilled.

The pursuit of a circular economy requires place-based response unique to Aotearoa New Zealand (Genovese and Pansera 2020). The principles of a circular economy align with many concepts in a Te Ao Māori worldview of resource use (WasteMinz 2020). For example, the concept of *Tauututu* has been presented in a circular economy context as it is relates to creating and maintaining relationships as part of a circular feedback and resource system (Reid et al. 2021). As discussed in the *Whakapapa-Centred Transformation of local economies* section of this project, *Te Ao Tuuroa* is a whole landscape approach that resists inputs that disrupt natural environmental functioning, such as the use of chemical fertilisers. The concept relates to designing out pollution and regenerating natural systems.

Te Tiriti o Waitangi

The transition to a circular economy will need to uphold Te Tiriti o Waitangi (MfE 2022b) through meaningful engagement and genuine partnership. Under the Local Government Act 2022, local government has responsibility to engage Māori in and contribute to decision making and support enhanced representation by Māori. It is noted that enabling Māori to shape and benefit from circular economy transition includes reflecting local context and system connections (MfE 2022b).

It should be acknowledged that most iwi entities have many demands on time and resources, limiting the capacity to engage with local government. As part of this project, initial consultation was carried out to assess to what extent the topic is of interest to iwi, what barriers might prevent engagement and what WRC can do to enable engagement in the issue. It was found that further consideration needs to be taken to connect organic material management across other strategies and priorities. How can these be connected to food security and climate change? This would be a first step to supporting meaningful engagement when these systems are put in place.

The Sustainable Development Goals

The principle of increasing social and cultural equity aligns with the Sustainable Development Goals (SDGs) (Padilla-Rivera et al. 2020) and will enable Aotearoa New Zealand's commitment to implement these. The SDGs are a set of 17 goals and concrete targets that have been agreed upon by the world community of states to make the world a better place (Victoria University 2023). At the regional level, the Waikato Wellbeing Project has been initiated to see the Waikato grow inclusive prosperity and environmental sustainability by 2030 (Waikato Wellbeing 2023). SGD 12 is focused on responsible consumption and production. The regional goal for SDG 12 is to increase the number of schools, businesses and farms who reduce their waste leading to a 50% reduction of waste to landfill by 2030 (Waikato Wellbeing 2023). This goal should be carried out while also linking across SDGs to ensure the maximum benefits for society and environment are being achieved. For example, SDG2 is zero hunger and SDG 13 is climate action. Diverting waste, especially organic material, can contribute to food growing and emissions reduction.

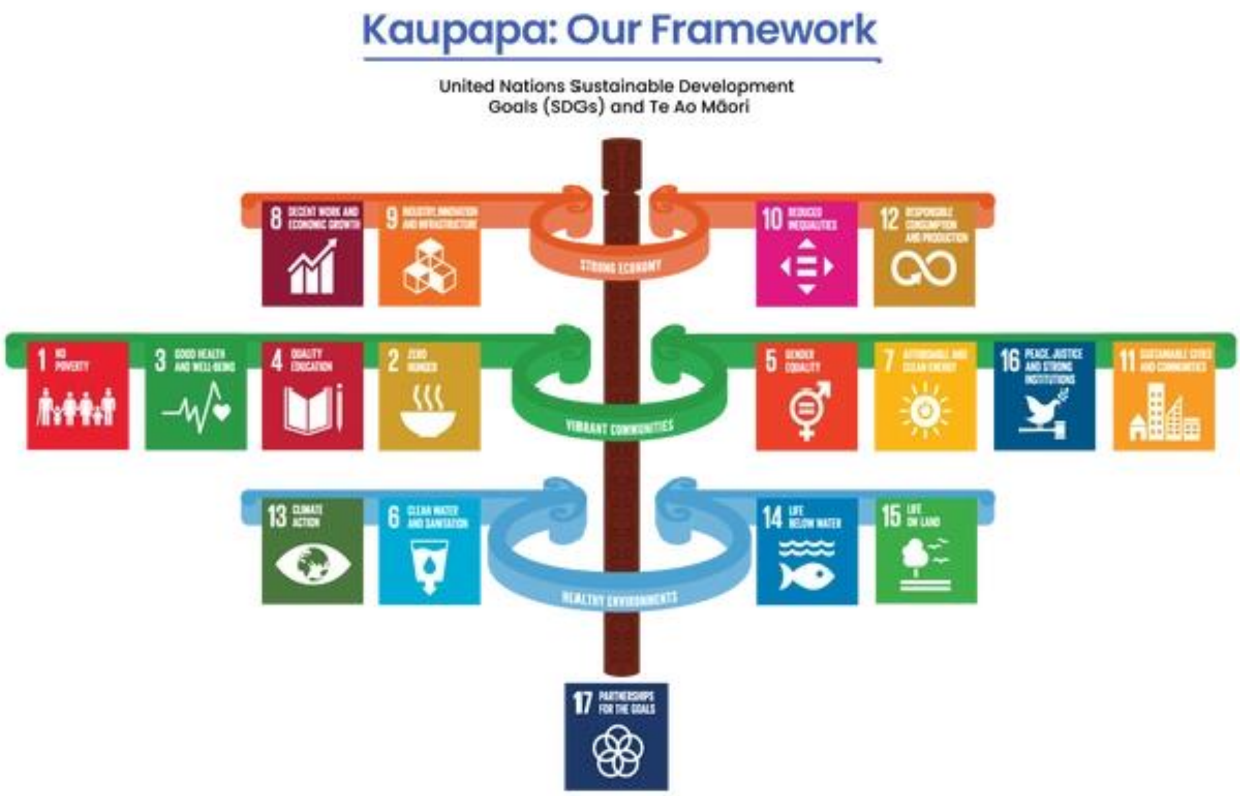
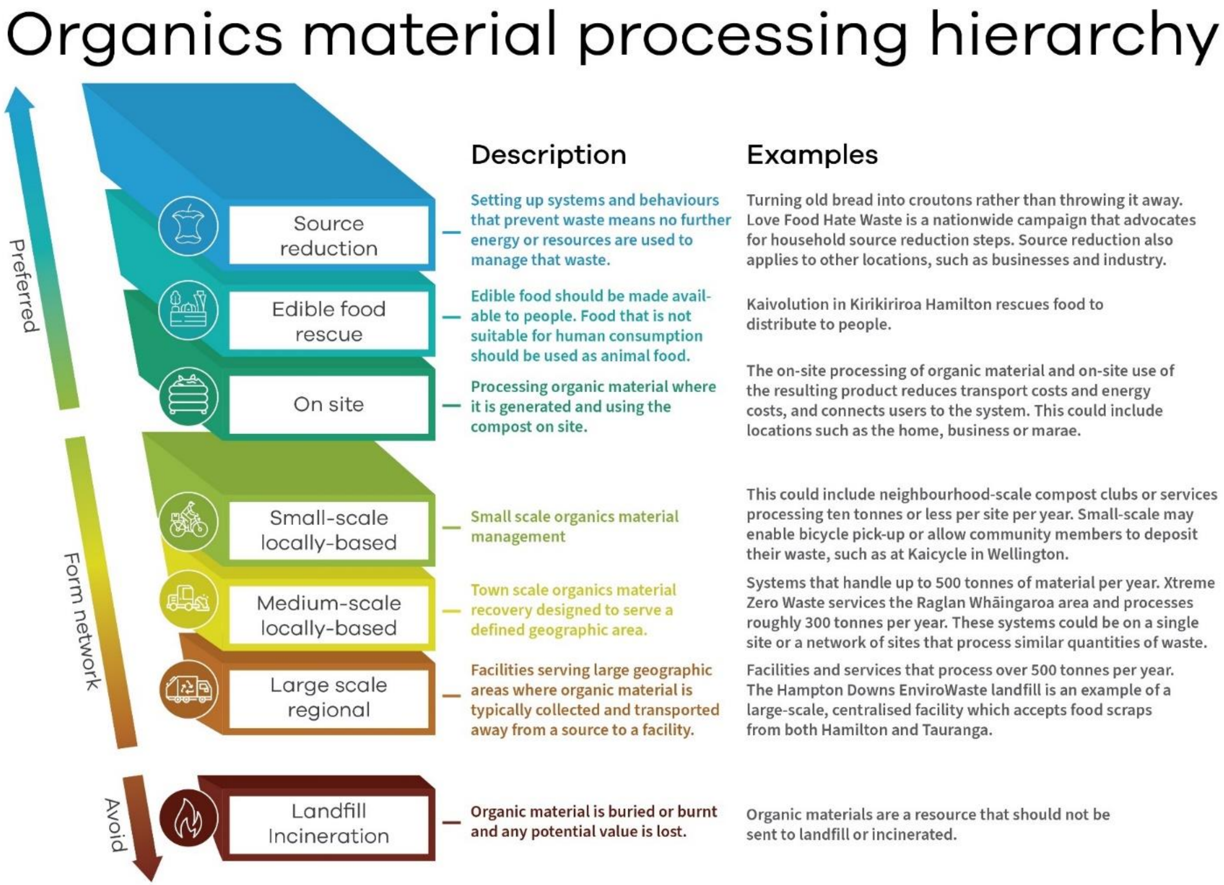


Figure 3 The SDG blueprint for the Waikato Wellbeing Project

A waste hierarchy for organics

The waste hierarchy helps to guide users toward preventing and managing waste to achieve the best environmental and social outcomes. There are many variations of the following waste hierarchy[1], but the general principle is to redesign systems and behaviour to prevent material from becoming waste in the first instance. Following this, subsequent steps down the ladder can be implemented. The following waste hierarchy was developed as part of the CO project and provides a link across research areas.

Note: While on-farm organics management system examples can be found overseas and in New Zealand, farms were not included in the examples. Some farms could be operating "on-site" systems, while others could accept material as part of a wider distributed network of processing sites. Further research is needed to better understand how farms could be and the implications of being integrated into a wider organics material management system



[1] For example, see Figure 2 in Te rautaki para Waste Strategy https://environment.govt.nz/assets/publications/Te-rautaki-para-Waste-strategy.pdf; the organic waste hierarchy by the Zero Waste Network http://zerowaste.co.nz/assets/Organic-Waste-in-Landfill_discussion-doc-2021.pdf; and the Hierarchy to Reduce Food Waste and Grow Community by the Institute for Self-Reliance https://ilsr.org/food-waste-hierarchy/

Appendix A - References

Bianchi V, Yates S 2022. The journey to a circular economy in the Waikato Region. Hamilton: Waikato Regional Council. TR 2021/34.

Blumhardt H. 2023. Working paper: Regulating products, production and consumption for a circular economy in Aotearoa New Zealand. Hamilton: University of Waikato.

Ellen MacArthur Foundation. N.d. What is a circular economy? [accessed 2023 November 28] https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

Eve L, van Gool E, Wilson D, Middleton B, and Yates S 2022. Waikato and Bay of Plenty region waste and recycling stocktake 2021. Hamilton: Waikato Regional Council. TR 2022/11.

Genovese A., and Pansera M 2020. The Circular Economy at a Crossroads: Technocratic Eco-Modernism or Convivial Technology for Social Revolution? *Capitalism Nature Socialism.* 32(2), 95-113.

Johansson N, and Henriksson M 2020. Circular economy running in circles? A discourse analysis of shifts in ideas of circularity in Swedish environmental policy. *Sustainable Production and Consumption*. 23, 148-156.

Ministry for the Environment (MfE) 2022a. Transforming recycling: Consultation document. Wellington: Ministry for the Environment.

Ministry for the Environment (MfE) 2022b. Aotearoa New Zealand's First Emissions Reduction Plan. Wellington: Ministry for the Environment.

Ministry for the Environment (MfE) 2023a. Food loss and waste definition for Aotearoa New Zealand. Wellington: Ministry for the Environment.

Ministry for the Environment (MfE) 2023b. Te rautaki para | Waste strategy. Wellington: Ministry for the Environment.

Ministry for the Environment (MfE) 2023c. Standard materials for kerbside collections: Guidance for territorial authorities. Wellington: Ministry for the Environment.

Padilla-Rivera A, Russo-Garrido S, Merveille N 2020. Addressing the Social Aspects of a Circular Economy: A Systematic Literature Review. *Sustainability* **2020**, *12*, 7912. https://doi.org/10.3390/su12197912

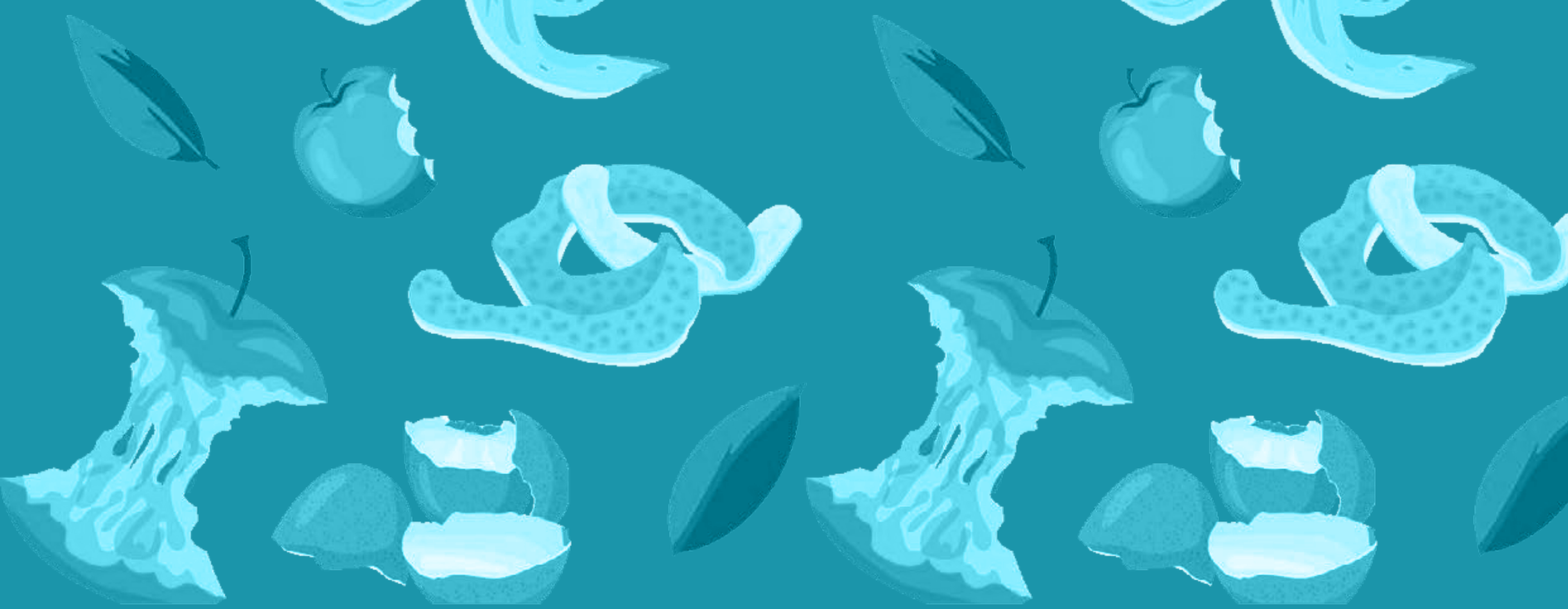
Reid J, Rout M, Whitehead J, and Katene T 2021. Tauututu: White Paper Executive Summary. https://ourlandandwater.nz/wp-content/uploads/2021/08/Tauutuutu_WhitePaper_ExecutiveSummary.pdf Accessed 8 July 2022

SDG.org.nz. 2023.What are the SDGs? – New Zealand Sustainable Development Goals. University of Wellington. https://www.sdg.org.nz/resources/what-are-the-sdgs/ Accessed 22 December 2023.

Waikato Regional Council (WRC) 2020. Waikato Regional Waste Prevention Action Plan 2020-2025. Hamilton: Waikato Regional Council

Waikato Wellbeing Project 2023. [Accessed 22 December 2023].
https://www.waikatowellbeingproject.co.nz/

WasteMINZ 2020. Recommendations for standardisation of kerbside collections in Aotearoa. Prepared for Ministry for the Environment. Auckland, WasteMINZ.



Chapter 1

Whakapapa-centred organics processing to transform local economies and communities across Waikato

Concepts discussion for whakapapa-centred transformation of local economies through organic waste processing across Waikato

Tamoko Ormsby
Whetū Consultancy Group

Amy Whetu
Whetū Consultancy Group

December 2023

This report discusses the potential of maatauranga Maaori to inform decision-making in the Circularising Organics Project. The report and subsequent discussions were used by the project team to inform other areas of research. Whakapapa is the fundamental concept that guides this approach toward “culturally-appropriate” decision-making in organics processing.

Contents of Chapter 1

1 Overview

This document discusses the potential of maatauranga Maaori to inform decision-making in the Waikato Regional Council ("WRC") Circularising Organics Project ("the project"). For the purposes of this analysis, the project has been reframed as a "whakapapa-centred transformation of local economies through organic waste processing".

Whakapapa is the fundamental concept that guides this approach toward "culturally-appropriate" decision-making in organics processing. The concept of whakapapa has been used as a central thread that weaves through this entire document.

The report considers the project through a whakapapa analysis of:

- Atua
- Whenua
- Tangata

The analysis is summarised as a set of critical questions that are intended to be used to guide decision-making, engagements, and influence the design and implementation of organics processing solutions in Aotearoa and the Waikato region.

2 Discussion

2.1 Whakapapa

Whakapapa is a genealogical framework of understanding the natural world that encodes relationships between flora, fauna and natural phenomena; whakapapa also details the kinship between all things. With these relationships comes the responsibility and the behaviours that are required to maintain them. Therefore, where *whakapapa* exists between people (tangata), place (whenua) and planet (atua), there also exists responsibility (Mead, 2003).

Whakapapa is a knowledge framework that has been empirically developed over thousands of years and localised to specific regions over hundreds of years. Unfortunately, it has taken mere decades of colonialism to almost eradicate these rich, intricate, and place-based ways of knowing. Therefore, the project presents us an opportunity to restore, reinforce and celebrate our unique Aotearoa New Zealand identity by embracing the Maaori concept of *whakapapa*.

> ***"In moving beyond the traditional maatauranga Maaori, maatauranga Maaori has grown into many contemporary forms (e.g., historic, local indigenous knowledge, Maaori perspectives) that are complementary to western science knowledge; a view consistent with many recent Maaori authors who regard Maaori knowledge as a dynamic and evolving knowledge system that represents more than the past (Durie 1998; Harmsworth et al. 2002; Raskin 2009; Roskruge 2012)."***

The use of whakapapa as a framework for organics processing opens a holistic, place-based, indigenous way of thinking that can add immense value to this project: either by providing an opposing view; reinforcing our unique identity of Aotearoa New Zealand; inspiring purpose through storytelling; connecting past and future generations; or through creating resilient solutions that prioritise Ranginui and Papatuuaanuku.

2.2 Atua

Atua (deities) are a central aspect of understanding the natural world. Ranginui (sky father) and Papatuuaanuku (earth mother) are predominantly placed as the primary atua. All activity on land and soil either enhance or degrade the wellbeing of Papatuuaanuku, with discharges to air impeding on the wellbeing of Ranginui. This provides initial cues as to how we should conduct our activities.

Harmsworth and Roskruge (2014) detail that from a Maaori perspective, their whakapapa connections place human beings in an environmental context with all other flora and fauna and natural resources 'as part of a hierarchical genetic assemblage, with identifiable and established bonds.' Further, that these connections place large responsibilities and obligations on Maaori to sustain and maintain the well-being of people and natural resources.

Paraphrasing Best, Buck and Keane, the authors note further these ancestral links to the soil:

> ***"All flora and fauna were the grandchildren (mokopuna) of Papa-tū-aa-nuku. In many stories the departmental god Taane Mahuta formed the first woman called Hine ahuone (woman made from earth) from soil before breathing life into her (Buck 1950; Rangitaane o Wairarapa***

> ***Inc. 2006; Keane 2011b). In other tribal stories, it was a man Tiki-aahua, who was formed from soil by Taane-mahuta (Best 1924b; Buck 1950; Rangitaane o Wairarapa Inc. 2006; Keane 2011b)."***

Roberts (2013) details whakapapa as follows:

> ***"Whakapapa as a philosophical construct implies that all things have an origin (in the form of a primal ancestor from which they are descended), and that ontologically things come into being through the process of descent from an ancestor or ancestors.***
>
> ***Further, because there is in Maori cosmogony only one set of primal parents or ancestors (Ranginui and Papatuuaanuku) from whom all things ultimately trace descent, all things are related. In its most familiar guise, that of recording human genealogies or 'family trees', whakapapa describes the descent and relationships of only one 'thing' or species; namely humankind (Homo sapiens) which, depending on tribal origins, can be traced back to one or other of the children of Rangi and Papa."***

This is an animistic worldview; one where all things are alive, animated and have *mauri*[2]. At its most basic level, this animist worldview determines what acts are permissible or unacceptable to *Rangi* and *Papa* due to the kinship between humanity and the non-human entities and natural phenomena that fill our world.

Of all the children of Rangi & Papa, the most relevant atua to our project are *Taane* (associated with the forest and procreation), *Tangaroa* (associated with the seas), *Rongomataane* (associated with cultivated foods), *Haumietiketike* (associated with uncultivated foods) and *Hineahuone* (associated with soils).

Taane is associated broadly to the forest, and by extension organic materials from the forest. Rongo is associated with horticultural activity and the cultivation of foods for our use, consumption, and wellbeing. Haumie is associated with the gathering and processing of uncultivated foods. Tangaroa is associated with the sea, and as such, any organic material from aquatic environments (Best, 1924).

This does not however limit the linkages to other atua, such as Mahuika (deity associated with fire and combustion) but rather serves to unpack and identify the links between atua and our project.

Hineahuone was made from the soils of Kurawaka and is attributed as the first human-being and the first woman in the Maaori creation story. There are many variations of this creation story, but most commonly Taane is attributed to breathing life into her body to bring her into the world. Hineahuone, as the first human woman, is therefore also the first mother, facilitating the connection between atua and humankind. Poignantly, Hineahuone is associated with soils; the primary mechanism by which nature processed organic waste.

---

[2] **Mauri** is when you have a sense of something that is greater than you, something that is divine, even your own divinity. Commonly referred to as life force, sensing *mauri* is best exemplified by the awe and inspiring energy we experience in the stillness of a living forest, or while in the vastness of an ocean. The mauri of drinkable water derived from chemically-treated wastewater is very different to that of clean rainwater or pure spring water; both are technically similar, however the mauri is different. (Korero with Kuia, Teina Boasa Dean)

Creating a culturally appropriate approach to processing organic materials requires ongoing inquiry into what will either enhance, or diminish, the kinship between humanity and the deities mentioned above. This is the basis of *tikanga* – the protocols that determine behaviour and how we responsibly conduct ourselves such that integrity of these whakapapa relationships is maintained.

2.3 Whenua

Whenua is the physical manifestation of Hineahuone and Papatuuaanuku; the primary female deities and first women; therefore, whenua carries a strong internal connection that is reinforced through whakapapa and the atua connection of Hineahuone.

The intentional connections between language and meanings for Maaori are further noted to echo these connections between whenua and tangata. Whenua as both placenta and land; rae as forehead or a land promontory, hapuu as pregnancy or sub-tribe.

Whenua also refers to "place" and the capacity of "place" to bring tangata and atua together, to create identity, histories, and legacies. These elements are captured through puuraakau (indigenous narratives). Descending further from Hineahuone to humanity, puuraakau speak of the acts achieved by our Maaori ancestors.

2.3.1 Te Kete o Whakaotirangi

One such puurakau speaks of the initial ancestors who voyaged to Aotearoa on the Tainui waka. This includes the captain of the waka, Hoturoa, and his wife Whakaotirangi. Whakaotirangi is famed for bringing a kete with various seed plants across the Pacific to Aotearoa including kumara, taro and hue. This is known as the 'small basket of Whakaotirangi' or *te kete rukuruku a Whakaotirangi.*

This puuraakau around Whakaotirangi reinforces the prevalence of horticultural traditions amongst Maaori and denotes the practices of subsistence horticulture as a means of survival and wellbeing; that is the intentional cultivation and repurposing of organic inputs for the survival and wellbeing of a people.

Notably, soils needed to be improved to compensate for the poor climatic conditions compared with the relative heat required for the taro, kumara and hue that arrived with Maaori to Aotearoa. Maaori quickly recognised the soil properties and types that were most effective. Noting the significant knowledge developed by early Maaori, clearly notes they were adaptive in their soil management and uses:

> ***"Maaori naming and categorizing of soils was not a systematic taxonomy but apparently intended for the management of root crops. Soil properties and conditions in the temperate climate needed to be improved and many soils were modified accordingly to lift crop success and productivity and extend the range, both geographic/areal and climatic, in which crops could be grown (Clarke 1977; McFadgen 1980; Leach 1984; Singleton 1988; McKinnon et al. 1997; Roskruge 2009, 2011). The soil qualities emphasized most were coarse texture, friable consistence, and fertility (Hewitt 1992). The increasing use of Maaori terms for soils and the classification of soils went hand in hand with advances Maaori made in horticulture and the planting of crops to increase planting success and yields (at 260).***

As such the organic cycle and understanding of soil characteristics is well-established within maatauranga Maaori and is the most familiar aspect of the emerging circular economy concept. Using these ancestral stories provides us the opportunity to weave meaningful connections into the project and assess its outcomes.

2.3.2 Te Kiingitanga ki Waikato

These horticultural histories extend into recent identities surrounding the *Kiingitanga* where Rangiaowhia, near Te Awamutu, was once deemed the "garden of New Zealand" in the 1800s. The ability to grow food on ancestral land is the ultimate sign of wealth and wellbeing of a people. It was the powerhouse of the Waikato economy and the commissariat of the Kingitanga movement during the land wars (O'Malley, 2016).

Waikato's ability to *manaaki*[3] was recognised by all iwi. As told by Waikato kaumaatua, this was one of the contributing factors why the mantle was given to Pootatau Te Wherowhero, the first Maaori king. His people would ultimately carry the responsibility of *manaakitanga* for all people of Aotearoa.

Culturally appropriate decision-making regarding food and organic waste in Waikato must integrate these *puuraakau* (intergenerational stories) that are part of Aotearoa and Waikato history and identity; this can add deep meaning, inspire purpose, and ground solutions in place.

2.4 Tangata

Analysing the whakapapa elements of the previous sections, we now discuss the *tangata* element – people, relationships, and community. Establishing organics processes that lead to cycles of wellbeing is ultimately a practical exercise of self-determination; the reclamation of identity connected to place, the reactivation of Waikato's sovereign food networks, and respecting kinship relationships with atua through responsible and regenerative behaviours.

These processes require the establishment of practices (tikanga) and principles (maataapono) to guide behaviour - our human-response - and inform appropriate development and implementation of solutions.

2.4.1 Tikanga

Hirini Moko Mead (2003) refers to tikanga as a set of beliefs associated with practices and procedures to be followed in conducting the affairs of a group or individual.

> ***"Whether there were values to which the community generally subscribed. Whether those values were regularly upheld is not the point but whether they had regular influence. Maaori operated not by finite rules (but) by reference to principles, goals, and values...Tikanga derived from 'tika' or that which is right or just."***

---

[3] **Manaaki** is most evident in acts of hospitality, the provision of food, or pastoral support in times of need. It is a means of acknowledging, respecting, and uplifting the unique authority of a person or people (Elder, 2020). Notably, *manaaki* is most enacted between two human parties within the cultural context of reciprocity, where actions are reciprocated proportionally between groups. A failure of manaaki is not only indicator of disrespect toward the receiving party or guest, but also a loss of credibility and mana from the provider or host.

Mead explains that these procedures are established by precedents through time, are held to be ritually correct, are validated by more than one generation and usually subject to what a group or individual can do. Tikanga is generally known as the way of doing things correctly; also known as traditional protocols, customs and practices. They have many elements including practical, spiritual, and ritual elements.

Translating a statement by Pou Temara and Mason Durie (2011):

> ***"Maaori wellbeing and survival is assured when tikanga have an Iho Atua, an Atua connection. If you cannot attach or connect that tikanga to an Iho Atua, well, it may not be a tikanga which can enhance your survival or wellbeing […] if you cannot connect your tikanga with an Iho Atua then, it is an expendable tikanga, it does not have any huge significance".***

Creating intergenerational wellbeing requires the establishment of modern tikanga to navigate new challenges. In our project context, tikanga that have an atua connection must be developed to maintain whakapapa connections to Atua and maintain the integrity of that tikanga.

As stated above, tikanga were established and validated by more than one generation, thus many tikanga descend from those put in place by ancestors (*tuupuna*). These are intentional acts performed by ancestors to ensure the survival and wellbeing of their descendants (many of which a held in puuraakau).

2.4.2 Rangaranga

It's important to note that the implementation of tikanga is varied; although, there can only be so much variation until that tikanga is broken. Underlying principles, or *maataaapono*, influence the appropriate implementation of tikanga, and allow for tikanga to be adopted for modern application.

For example, some tikanga have been put to rest as they are no longer appropriate, such as *utu*[4] and *makutu*[5].

Others have been reinterpreted and adopted to modern times, such as monetary *koha* and the facilitation of online *tangihanga* (funerals).

The discourse (*rangaranga*) around what is deemed appropriate as a tikanga in practice is determined by many factors; the *mana whenua* (governing authority), the *marae* (location), the *haukaainga* (community), and *pou* (experts that may be *kuia* and *kaumatua*). Notably, the relationships with marae, haukainga, mana whenua and pou are critical in the establishment of tikanga that allows for any forward momentum in any context; the presence, or absence, of these groups is therefore an essential determinant of project success.
The common ground where critical discussion occurs is in the shared principles that tie these groups together. For example, *manaakitanga* is a principle that is generally agreed upon, and therefore a *manaakitanga* led discussion can take place around the subject matter.

---

[4] **Utu** is the ceremonial practice of retribution and restoration of balance. Utu is triggered through an imbalance, such the failure of one party to manaaki another. The most extreme instances of utu included war and death; however balance can be restored by non-violent means. Today, utu is not as extreme, and can take the form of social conflict resolution, legal action or spiritual restoration of balance through karakia (Mead,2003).
[5] **Makutu** is the now prohibited act of "inflicting physical and psychological harm and even death through spiritual powers, bewitching, or to cast spells (Moorfield, 2005)

Therefore, in creating a “culturally-appropriate” response, and adopting tikanga that govern behaviours, we must consider the interaction between these parties, and the underlying principles by which they can share an engagement.

2.4.3 Maataapono

To achieve a synergy and inspire action amongst these groups, the project should establish principles by which diverse Maaori groups, agendas, iwi identities, marae, and haukaainga can have an open discussion around.

In this respect, there are two frameworks that should be further explored to base our project principles around.

Firstly the Hua Parakore principles presented by Te Waka Kai Ora National Maori Organics Authority of Aotearoa (Hutchings, 2018) and secondly, the Matike Mai Aotearoa values prepared by the Iwi Chairs Group Constitutional Transformation Working Group.

This combination allows the navigation of the inherent historical and current political nuances of transforming local economies, while remaining grounded in whakapapa-led maatauranga Maaori.

2.4.4 Hua Parakore principles (Hutchings et al, 2012)

> **“Hua Parakore is a kaupapa Maaori framework for growing organic kai. More specifically, it is an Indigenous validation and verification system to produce pure food or kai atua.”**

The key Hua Parakore principles are defined as being 6 interrelated kaupapa Maaori principles from a maatauranga Maaori continuum ‘through which diverse tikanga of whanau, hapuu and iwi can be applied in order to produce kai atua’. The principles are:

- Whakapapa – bringing an indigenous ordering system to the natural world, connection between all entities, land and water, atua, producers and everything produced
- Wairua – the spiritual health and peace of the land and the food and the people
- Maaramatanga – enlightenment and insight: development of observational skills and understanding nature
- Mauri – the essence of life, the energy and the vibration that is required to produce kai atua – practices that both maintain and enhance mauri
- Mana – the autonomy, security and self-determination of Maaori tribal collectives as expressed through mahinga kai. Improving the micro-biology and the wellbeing for example, enhances the mana
- Te Ao Tuuroa – a whole of landscape approach, it is the natural order of the living world which humans are an inextricable part of – includes a resistance to inputs that disrupt the natural order, such as chemical fertilisers, pesticides, herbicides and genetic modification and nanotechnology

There is discussion of the specific verification system that brings components of these key principles into play as a cohesive system for monitoring and verifying those producers utilising the Hua Parakore principles in practice. This being validated by Te Waka Kai Ora National Maaori Organic Authority.

2.4.5 Matike Mai values (The Report of Matike Mai Aotearoa, 2016)

The second set of principles (specifically values) come from the Matike Mai Report on Constitutional Transformation. The inclusion of values for constitutional transformation may seem out of scope at first glance, however, this project serves as a catalyst for transforming local economies. As such, these values should guide that transformation.

Jackson (2020) speaks of the creation of these values as part of reconciliation and the wider ethic of restoration; these values are extremely relevant in the recentering of Papatuuaanuku at the heart of our economic system.

- The value of place – that is the need for a constitution to promote relationships with, and ensure the protection of Papatuuaanuku.
- The value of tikanga – that is the need for a constitution to relate to or incorporate the core ideals and the “ought to be” of living in Aotearoa.
- The value of community – that is the need for a constitution to facilitate the fair representation and good relationships between all peoples.
- The value of belonging – that is the need for a constitution to foster a sense of belonging for everyone in the community.
- The value of balance – that is the need for a constitution to ensure respect for the authority of rangatiratanga and kaawanatanga within the different and relational spheres of influence.
- The value of conciliation – that is the need for a constitution to have an underlying jurisdictional base and a means of resolution to guarantee a conciliatory and consensual democracy.
- The value of structure – that is the need for a constitution to have structural conventions that promote basic democratic ideals of fair representation, openness and transparency.

3 Critical questions

The analysis above opens the floor for discussion with the wider team around how to integrate these concepts into decision-making. The discussion has been summarised into a set of key questions to prompt discussion in our evaluation of "culturally-appropriate" solutions for organic waste processing.

No.	Question	Links
1A	What is the whakapapa of the proposed solution?	Whakapapa
1B	Has the solution been developed and implemented overseas?	Whakapapa
1C	What is the state of indigenous representation in the location of origin?	Whakapapa
1D	What is the level of indigenous knowledge in the original solution?	Whakapapa
1E	What was the role of indigenous people in the design, development, and implementation of the solution?	Whakapapa
2A	How does this impact Rangi & Papa?	Atua
2B	How does this impact our relationship with atua?	Atua
2C	Does the activity enhance or diminish relationship with atua?	Atua
3A	What unique stories of Aotearoa/Maaori/Waikato resonate with the proposed solution?	Whenua
3B	What role does this proposed solution play in the ongoing story of Aotearoa/Maaori/Waikato?	Whenua
3C	Is this a continuation of the oppression faced by Maaori in Waikato, or, does this story hold an upward trajectory for Maaori in Waikato?	Whenua
4A	Who are the mana whenua / marae / haukaainga / pou in the space of establishing tikanga?	Tangata
4B	How are these roopuu actively involved in the proposed solution?	Tangata
4C	What are the tikanga that are guiding this solution?	Tangata
4D	At a technical level, assess the Hua Parakore principles against the proposed solution	Tangata
4E	At a transformational level, assess the Matike Mai values against the proposed solution	Tangata

4 Conclusion

In summary, the discussion and resulting questions are an initial analysis of what will be an ongoing dialogue with the various roopuu (groups) involved in this project. These questions can be used at an initial stage to critically assess any proposed organics processing solution. These are not intended to substitute actively engaging with Maaori, but serve to better prepare solutions and build a level of cultural competency in solution design prior to engaging with Maaori.

Appendix A - Bibliography

Best, E. (1924). Maori Religion and Mythology... Part I. Government Print.

Best, E. (1924). Maori Religion and Mythology... Part II. Government Print.

Buck, P. H. (1952). The coming of the Maori.

Elder, H. (2020). *Aroha: Maori wisdom for a contented life lived in harmony with our planet*. Random House.

Harmsworth, G., & Roskruge, N. (2014). Indigenous Maori values, perspectives, and knowledge of soils in Aotearoa-New Zealand. The soil underfoot: infinite possibilities for a finite resource, 111.

Hutchings, J., & Smith, J. (Eds.). (2020). Te Mahi Oneone Hua Parakore. Harvest: Fresh Scholarship from the Field.

Hutchings, J., & Tākupu, T. (2020). Te mahi māra hua parakore: A Māori food sovereignty handbook. Te Tākupu.

Hutchings, J., Tipene, P., Carney, G., Greensill, A., Skelton, P., & Baker, M. (2012). Hua Parakore: an indigenous food sovereignty initiative and hallmark of excellence for food and product production. *Mai Journal*, *1*(2), 131-145.

Kiddle, R., Jackson, M., Elkington, B., Mercier, O. R., Ross, M., Smeaton, J., & Thomas, A. (2020). *Imagining Decolonisation* (Vol. 81). Bridget Williams Books.

Marsden, M. (2003). The woven universe: selected writings of Rev. Māori Marsden. Estate of Rev. Māori Marsden.

Mead, H. M. (2003). Tikanga Māori. Living by Māori values. Wellington, New Zealand: Huia Publishers.
Moorfield, J. C. (2005). Te aka: Māori-English, English-Māori dictionary and index. Longman.

Mutu, M., & Jackson, M. (2016, February). He Whakaaro Here Whakaumu Mō Aotearoa: The Report of Matike Mai Aotearoa-The Independent Working Group on Constitutional Transformation. National Iwi Chairs Forum and Te Wānanga o Waipapa, University of Auckland.

O'Malley, V. (2016). The Great War for New Zealand: Waikato 1800–2000. Bridget Williams Books.

Roberts, M. (2013). Ways of seeing: Whakapapa. Sites: a journal of social anthropology and cultural studies, 10(1), 93-120.

Te Kōtihitihi : Ngā Tuhinga Reo Māori. (2011). University of Waikato.

Chapter 2

Situational overview

Chris Purchas
Tonkin + Taylor

Ben Riordan
Tonkin + Taylor

Natasza Letowt-Vorbek
Tonkin + Taylor

Anna Ainsworth
Tonkin + Taylor

Zoe Yandell
Tonkin + Taylor

Soph Brockbank
Tonkin + Taylor

Hannah Kelly
Tonkin + Taylor

December 2023

This report includes information and data to support decision making. This includes an overview of existing regulations and policy that relates to organic material. An overview of organic material recovery approaches and kerbside delivery/hardware options is provided. Data in the Waikato is given, including organic material generation, existing collection services and processing facilities to date. Product end markets are covered with emphasis on industry markets, including horticultural demand. Finally, a review of regional barriers and opportunities is provided.

Contents of Chapter 2

Executive summary

This report provides factual information to support Waikato Regional Council's Circularising Organics project. The purpose of the Circularising Organics project is to improve information and provide guidance to various key stakeholders with the ability to contribute to circularising organics.
The focus of this report is to:

- Analyse existing regulations
- Calculate compost volumes from feedstocks
- Identify existing businesses and facilities – collections and processing
- Set out existing or potential markets
- Review compost markets, barriers and opportunities
- Kerbside delivery/hardware options

Analysis of existing regulations: Themes from recent central government strategies and existing legislation focus on New Zealand's transition towards a low-emissions and low-waste society. New Zealand standards for organic materials indicate that there is a lack of regulatory framework for organic materials derived products, leaving standards as voluntary or determined by market expectations. The absence of strict regulations offers both flexibility and challenges for industry stakeholders in an evolving policy environment.

Calculation of compost volumes from feedstocks: Understanding the dynamics of compost production will provide a basis for decision-making in the later stages of the project. Desktop information supported by on-the-ground conversations indicated that there is more than 370,000 tonnes of organic materials generated per year available in the Waikato. It is important to recognise that the quality and volume of the compost produced varies; systems require maintenance and management to produce better quality outputs, and inputs vary depending on season and rainfall patterns.

Identify existing businesses – collection and processing: Identifying existing collectors and processors of organic materials is crucial for identifying potential collaborators, optimising processes, and leveraging existing infrastructure. Aerated static pile composting, anaerobic digestion, in-vessel composting, windrow composting and vermicomposting have all been established in the Waikato, Bay of Plenty and Auckland regions. High level estimates indicate that more than 200,000 tonnes of organic materials are processed in the region per year.

Set out existing or potential markets: A strong understanding of the market for organic materials is essential to establish sustainable and economically viable solutions for circularising organics. Some of the key benefits from utilising the processed organic material outputs include soil amendment (improved soil structure, nutrient replacement and improved moisture retention), but also as an input for stock feed, and alternative fuels (transport fuels and industrial heat). The value and use of the processed organic materials differs substantially depending on the type, location, quality and quantity of materials.

Review of compost markets, barriers, and opportunities: The combination of public perception, increasing landfill costs, and demand for outputs have resulted in a large opportunity to grow the market for products derived from organic materials. The most significant barrier to the production of compost type products is access to a steady supply of feedstock which is free from contamination. Industries including horticulture and agriculture are familiar with compost type products and understand the benefits of these products. Markets emerging for products including digestate are being established, and are expected to grow as quality standards and guidelines for application are established.

Most crucially, quality outputs from organics processing rely on quality inputs. Quality inputs will be impacted by variables include, but not limited to collection frequency, aeration of materials, access to depackaging for commercial food wastes, and seasonality.

Kerbside delivery/ hardware options: In New Zealand, organic materials at a household and commercial scale are generally collected via 23L food organics (FO) bins, 80-240L food and garden organics bins (FOGO), and 240-480L green waste only (GO) bins. Trucks with custom-built containment, or trucks fitted with an automated/ remote lifting system are most often used for the kerbside collection of organic materials from households. Where large quantities of materials are generated, organic materials may be collected in 660L – 4.5m^3 bins. These larger bins require rear or front loader vehicles to be used.

1 Introduction

Tonkin & Taylor Ltd (T+T) have been engaged by Waikato Regional Council to improve information and provide guidance to various key stakeholders with the ability to contribute to circularising organics. Because what materials are defined as "waste" can vary by situation, this project refers to materials as waste when there is a cost incurred to treat or dispose the material.

The overall project aims to enable the 'circularising of organics' through the delivery of the following:

- Engagement with Iwi to seek their views on organic waste from both a Te Ao Māori perspective and as partners in delivering solutions (processing, collection, users of product).
- Understanding organic material flows – how much is produced, where and what quantity of useful products could this be used to make.
- Consideration of key relevant standards – processing, products (BioGro, NZS4434), nutrients applied to land.
- Guidance on processing options for various organic waste materials.
- Guidance on organic waste collection options for local authorities.
- Considering the role of behaviour change in enabling a circular economy for organic materials.

This project is to be delivered in four milestones:

- Milestone 1 – Data collection (this report will contribute to this milestone)
- Milestone 2 – Organics processing guidelines
- Milestone 3 – Decision making matrix
- Milestone 4 – Final reporting

The focus for Milestone 1 is providing factual information to support the later stages of the project with tasks relevant to Milestone 1 listed below:

- Analysis of existing regulations
- Calculation of compost volumes from feedstocks
- Identify existing businesses – collection and processing
- Set out existing or potential markets

- Review of compost markets, barriers and opportunities
- Existing end point facilities
- Existing collection services
- Kerbside delivery/hardware options

The scope of work that T+T completed for this stage of the project (Milestone 1), documented in this report, is set out in our response to the RFP dated 15 March 2022 and agreed under contract RUD2022/2023-1917, signed 27 April 2022.

2 Analysis of existing regulations

This section lays out the existing regulations and standards regarding processing, products and nutrient application to land as it currently stands for the Waikato and Bay of Plenty regions. A figure by the Ellen McArthur Foundation (2022) has been adapted (Figure 2-1) to illustrate how the different components of this project link into the circular bioeconomy. Note, additions to the circular bioeconomy are in red.

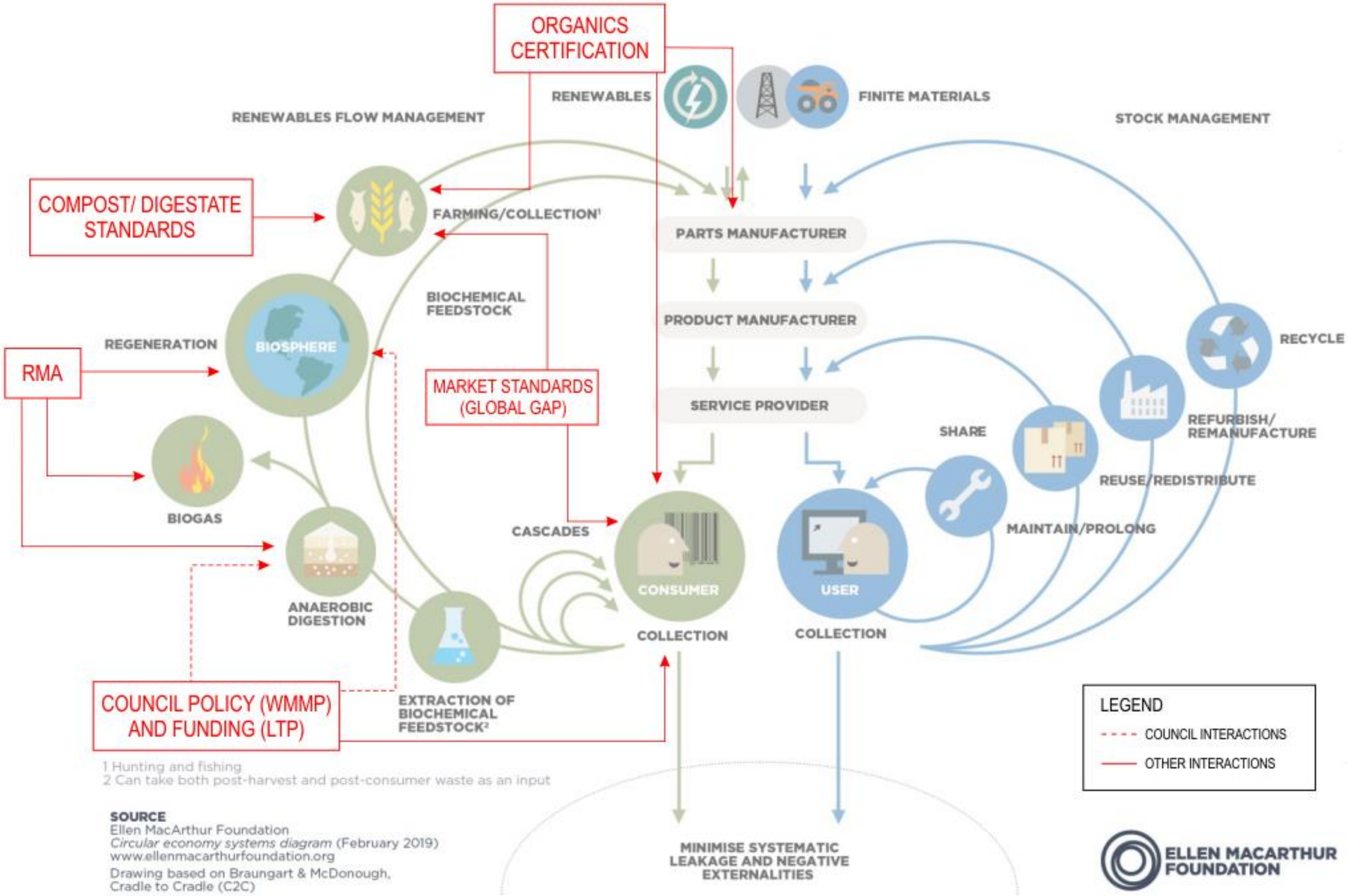


Figure 2-1: Aspects of project overlapping with circular economy principles (adapted from the Ellen McArthur Foundation, 2022)

2.1 National policy and priorities

Central Government guides the direction of waste and resource management within New Zealand. A range of legislation and policy sets the framework for waste management and resource recovery in New Zealand.

The purpose of specific components vary but overall the intent, in alignment with the new Waste Strategy (2023), is to transition towards a low-emissions, low-waste society, built upon a circular economy.

Key components of the framework include the Waste Minimisation Act (2008), currently under review), Resource Management Act (1991), The Climate Change Response Act (2002). This legislation enables the wase disposal levy, the Waste Minimisation Fund, the Emissions Reduction Plan (2022) and the recently released Te rautaki para Waste Strategy (2023). The Local Government Act 2002 sets the framework for local government activity and is also relevant for funding local government activity related waste management and resource recovery. Further details are provided in the following sections and Appendix B.

2.1.1 The Waste Minimisation Act 2008 (under review)

The Waste Minimisation Act 2008 sets a framework to encourage a reduction in the amount of waste generated and disposed of in New Zealand, minimising environmental harm from waste and providing economic, social and cultural benefits. The Act includes provisions related to imposing a waste disposal levy, establishing the Waste Minimisation Fund and enabling voluntary and mandatory product stewardship.

The Waste Minimisation Act 2008 enables the imposition of a **waste disposal levy**. Originally applied to disposal sites accepting household waste, the scope of the levy has now been expanded to include a wider range of disposal sites including construction and demolition fill (class 2) and managed or controlled fill facilities (class 3 and 4). From July 2021 the New Zealand Government has been progressively increasing the national waste disposal levy from $10 per tonne to $60 per tonne in July 2024 for Class 1 landfills. At the time of writing, the waste disposal levy is $20 per tonne. 50 % of the funds collected through the waste disposal levy are allocated to Councils; distributed on a population basis each financial year. The remaining 50 %, minus central government administrative costs, goes into the contestable national Waste Minimisation Fund.

- Revenue from the waste disposal levy must be used to promote or achieve waste minimisation, with the Ministry for the Environment (MfE) indicating a desire for a greater focus from Councils on improving local waste management and minimisation infrastructure.
- Councils are also able to apply for funding for larger projects through the Waste Minimisation Fund.

Under the Waste Minimisation Act 2008 territorial local authorities are required to have a **Waste Management and Minimisation Plan** (WMMP). The WMMP sets out Council priorities and activities for waste and resource recovery and must be reviewed every 6 years. The Waste Minimisation Act 2008 outlines that local government waste disposal levy funding can only be spent on waste minimisation activities in accordance with a councils WMMP.

Although the WMA is the current legislative instrument for directing territorial authorities on their waste related obligations, this Act (alongside the Litter Act 1979) is currently undergoing a repeal and replace process by Central Government. Central Government has indicated an intention for the replacement act to be in place by 2025 and has highlighted that the new legislation will provide clear roles and responsibilities for central and local Government. Central Government have also signalled that the new legislation will broaden the scope of what the waste disposal levy funds can be spent on, strengthening the alignment to the purpose and principles of the new Te rautaki para Waste Strategy (2023).

2.1.2 The Resource Management Act 1991 (under review)

The Resource Management Act 1991 promotes sustainable management of natural and physical resources. Although it does not specifically define 'waste', the RMA addresses waste management and minimisation through controls on the environmental effects of waste management.

Government has signalled reform of the resource management law with the shape of this reform yet to be laid out in details.

2.1.3 Climate Change Response Act 2002

The **Climate Change Response Act 2002** puts in place a legal framework to enable New Zealand to meet its international obligations under the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement. The Act was amended in 2019 to provide a framework by which New Zealand can develop and implement clear and stable climate change policies that:

- Contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5 degrees Celsius above pre-industrial levels.
- Allow New Zealand to prepare for, and adapt to, the effects of climate change.

2.1.4 The Local Government Act 2002

The **Local Government Act 2002** covers a wide range of local government activities, all with the purpose of promoting social, economic, and environmental wellbeing both now and in the future. Of particular relevance to waste management and resource recovery is the requirement to develop a Long Term Plan setting out Council priorities and budgets over a 10 year timeframe. The Long Term Plans are where spending set out in Council's Waste Minimisation and Management Plans are actually committed.

2.1.5 New Zealand Waste Strategy

In March 2023 MfE released **Te rautaki para | Waste strategy.** The vision for Te rautaki para Waste Strategy is that "by 2050, Aotearoa New Zealand is a low-emissions, low-waste society, built upon a circular economy. We cherish our inseparable connection with the natural environment and look after the planet's finite resources with care and responsibility" (Ministry for the Environment, 2023 p.18).

Te rautaki para Waste Strategy sets the direction over the next three decades for work on waste by central and local government, the waste management sector, individual industries and businesses, and households and communities. At the time of issuing this report, Te rautaki para Waste Strategy is not considered statutory, beyond territorial local authorities needing to have regard of it in the preparation of their WMMP. However, as already noted, the Waste Minimisation Act 2008 is currently under review and any decision to strengthen the statutory status of te rau taki para will be made by the incoming government.

The 2023 strategy is focused on directing a collective journey towards a circular economy for New Zealand with a vision that is guided by a set of six principles:

- Take responsibility for how we make, use, manage and dispose of things.
- Apply the waste hierarchy preferences to how we manage materials.
- Protect and regenerate the natural environment and its systems.
- Deliver equitable and inclusive outcomes.
- Ensure our systems for using, managing and disposing of materials are financially sustainable.
- Think across systems, places and generations.

The priorities of Te rautaki para Waste Strategy are aligned with the report Ināia tonu nei: a low emissions future for Aotearoa released by the Climate Change Commission in June 2021. These include:

- Reducing waste.
- Diverting organic waste from landfill to recycling or composting.
- Improving and extending landfill gas capture systems.

Together these priorities provide direction as to how New Zealand could meet its international emissions reduction commitments and its obligations under the Climate Change Response Act 2002 and actions that relate to waste. The Emissions Reduction Plan (see below) responds to the analysis and suggestions including actions addressing the disposal of organic waste to landfill.

Te rautaki para Waste Strategy is a key implementation mechanism for the waste and resource recovery components of the Emissions Reduction Plan, and it includes actions for organic materials recovery.

2.1.6 Emissions Reduction Plan (2022)

The **Emissions Reduction Plan** was released in 2022 and is a mechanism to allow New Zealand to prepare for, and adapt to, the effects of climate change, transitioning towards a more resilient low emissions economy. The Plan sets out policies and strategies for the decarbonisation of every sector. In terms of waste, organic waste has a key focus at both a household and business level alongside exploration of bans or limits for the diversion of organic materials from landfill.

2.1.7 Transforming Recycling (policy review has resulted in the new Te rautaki para Waste Strategy and proposed legislative change)

In early 2022, MfE consulted on three proposals to transform recycling in Aotearoa New Zealand which included:

- Improvements to kerbside recycling (including standardisation of bin services across local government areas and mandating food waste collection).
- Introduction of a container return scheme (CRS).
- Separation of business' food waste.

In March 2023, alongside the release of the new Te rautaki para Waste Strategy, the Government announced changes to kerbside recycling and food scraps collections. This includes specific requirements for all district and city councils, which need to be implemented between 2024 and 2030 (Ministry for the Environment 2023):

- Councils across Aotearoa will accept the same materials in their household collections.
- Recycling collections will be available to households in all urban areas.
- Food scraps collections will be available to households in all urban areas.
- Minimum standards for councils to divert waste from landfill.
- Waste companies, operators and councils required to collect and report more of their waste data.

All councils will need to meet an increasing minimum standard for the amount of household waste diverted from landfill. These changes will have an impact on council services and demand for organic materials recovery across the country.

2.1.8 National Waste Action and Investment Plan

Te rautaki para Waste Strategy focuses on the high-level direction. The Government has proposed a waste and resource recovery focused Action and Investment Plan (AIP) which will sit underneath the strategy (Ministry for the Environment 2023). The AIP is indicated to include:

- The immediate priorities for the next five years in different geographical areas, communities, material streams and risk areas,
- The mix of regulatory, investment, infrastructure, systems and behavioural change and other actions planned to address the immediate priorities,
- The sequence of the actions and how they fit together.

2.2 Regional policy and priorities

Local Government is required to implement regional and district specific measures and frameworks to manage waste and resources. Regionally, Waikato has the Waikato regional Policy Statement and Waikato Regional Plan (in the context of the Resource Management Act 1991).

In relation to waste management, there is a focus to reducing waste and viewing waste that is generated as a resource with value.

2.2.1 Waikato Regional Council Long Term Plan (2021-2031)

The Long Term Plan (Waikato Regional Council 2021) sets out Waikato Regional Council's vision, direction, work plan and budgets for the next ten years. In relation to waste, the LTP focuses on reduction in waste generated in the region.

2.2.2 Waikato Regional Plan

The Waikato Regional Plan (Waikato Regional Council 2021) sets out the rules which are applicable to the region in relation to the Resource Management Act 1991. The rules which relate to organic waste processing activities are detailed in Chapter 3 'Water Module' and Chapter 5 'Land and Soil Module'.

Chapter 3 includes rules under Section 3.5 'Discharges', 3.9 'Non-point source discharges' and 3.10 'Lake Taupo Catchment' which stipulate nutrient budgeting, analysis and management plan requirements. These rules require the landowners / occupiers (consent holders) to control the nutrient discharge to land and water. There is a particular focus on contaminants leaching into the Waikato River.

Chapter 5 includes rules under section 5.2.8 in relation to 'Composting of Green Waste and Other Organic Materials'. Rules 5.2.8.1, 5.2.8.2 and 5.2.8.3 stipulate the current volume, feedstock, location, and discharge requirements for composting activities in the region. Where any discharge of contaminants onto or into land, water or air associated with the composting of organic waste activity falls outside of these rules, a resource consent is required under rule 5.2.8.4. Further detail can be found in Appendix B.

2.2.3 Waikato Prioritisation Framework and its use for soil conservation – development and methods (2021)

The Waikato Prioritisation Framework (Norris M. et al 2021) provides a consistent approach for the planning and implementation of the mitigations for soil conservation across the region. The Framework comprises a series of components and geospatial processes that collectively are used to simplify the use of data from multiple models. The tool can be applied to a region or sub-catchment (354 total sub-catchments in the Waikato Region) to show locations with high to low risk for soil conservation, water quality or biodiversity factors. Further detail can be found in Appendix B.

This framework is relevant to the reuse of organic materials to improve soil quality, including reducing erosion through improved soil structure.

2.2.4 Waikato Regional Waste Infrastructure Stocktake and Strategic Assessment (2007, 2015, 2021)

The Waikato Regional Waste Stocktake and Strategic Assessment[6] (Yates S et al. 2021) details the current situation for the region. Information on the processing of organic materials (garden waste, food processing waste and wood processing waste) was limited to mainly garden waste via composting, wood processing waste via boiler fuel with the remaining stockpiled or sent to landfill.

The documents note that significant improvement can be made in relation to recovering organic waste with recommendations made for a regional options study. The report details the most appropriate processing options food waste in Waikato is composting, anaerobic digestion and vermicomposting. Further detail can be found in Appendix B from page 98.

2.2.5 Waikato River Documentation

The Waikato River Authority (WRA) was established in 2010 and aims to restore and protect the health and wellbeing of the Waikato River. With an organic waste lens, the authority has an interest in how waste affects the water quality. There is a focus on how processes within the Waikato can be improved to address water quality issues, with a holistic view to protect the health and wellbeing of the Waikato River for future generations.

The WRA have produced a number of documents which support their purpose:

- A tool for freshwater nutrient management in the Waikato-Waipa catchment (Waikato Economic Impact Joint Venture 2015).
- Restoring and protecting health and wellbeing of the Waikato River (Guardians Establishment Committee 2019).
- Waikato River Independent Scoping Study, Appendix 13: Water Quality (National Institute of Water and Atmospheric Research Ltd 2010).

These documents detail the current situation which focuses on the effects that past activities have had on the land around the Waikato River catchment. Contaminants leaching into the river from

[6] The Waikato Regional Waste Infrastructure Stocktake and Strategic Assessment was first released in 2007, with updates being published in 2017 and 2021. The 2021 stocktake has informed this report.

industry is a key area the WRA would like to address. Further detail can be found in Appendix B from page 98.

2.3 Territorial authorities

Territorial Authorities have responsibilities under the Local Government Act 2002, Waste Minimisation Act 2008 and the Resource Management Act 1991.
Waste Management and Minimisation Plans (WMMP), developed in accordance with the requirements of the Waste Minimisation Act 2008, are developed by each Council. WMMP set out the priorities and strategic framework for the minimisation and management of waste in the specific districts. Reviews are completed every six years to ensure relevance and continual improvement.

As part of the Waikato and Bay of Plenty Region Waste and Recycling Stocktake (Yates S et al. 2021) a review of WMMP across the regions was undertaken. Common themes across the WMMPs were drawn out with organic waste management being one of the key themes highlighted from this review.
Each Territorial Authority must have a Long Term Plan, prepared to meet the requirements of the Local government Act 2002. The Long Term Plan is a key planning tool for councils, describing the council's activities and the community outcomes it aims to achieve. The LTPs are where budgets are committed to implement actions set out in each Council WMMP.

Councils also develop District Plans under the Resource Management Act 1991. District Plans manage land use and associated impacts in each District. District Plans may have provisions relating to the processing of organic materials.

2.4 New Zealand standards

There are a number of standards written for producers of soil products (compost, soil conditioners, mulches), horticulture, livestock, flowers and ornamentals. The purpose of these standards is to provide producers, distributors and users/ consumers with assurance of the quality of the product.

Within New Zealand there is no regulatory framework or directive requiring producers to comply with standards relevant to the production or use of organic materials derived products. Therefore, the standards and guidelines detailed in Appendix B are voluntary to producers or may have been stipulated within contractual agreements with suppliers, particularly those who supply to overseas markets where standards are often mandated.

Organic production standards (for example BioGro and Assure Quality) cover production methods and inputs to the production system. For compost and similar production system inputs they predominately stipulate a requirement for inputs to the compost production to be from organic sources (either the site itself or a certified off-site location). On organic farms there is an emphasis on analysing the soil profile (with some testing requirements) to understand the nutrient profile and to only add feedstock, fertilisers or other chemicals which are from a natural origin.

The standards noted below have differing requirements surrounding the use of manures although all standards ban the use of human sewage sludge in compost production. Further details can be found in 0.

The key standards are:

- New Zealand Standard 4454 – Compost, soil conditioners and mulches (2005) - The standard prescribes compositional requirements, compliance requirements, sampling and testing methods for composts, soil conditioners and mulches.
- BioGro (organic product certifier) - a certification for producers who are looking for organic certification, owned by the Soil & Health Association of New Zealand. The primary principle is that all inputs are required to be organic certified enabling the best organic products to be produced (Biogro n.d.).
- Asure Quality – Organic Standard (2020) - (accredited by the international organic organisation IFOAM - International Federation Organic Agricultural Movement) has been produced for organic producers, processors and retailers in the dairy, meat, seafood, horticulture, wine and arable sectors.
- Global G.A.P. - The Global G.A.P. standard is applicable to any producer of primary agricultural products (Global G.A.P n.d.). Integrated Farm Assurance (IFA) is GLOBAL G.A.P.'s flagship standard. Developed in consultation with stakeholders across the entire global supply chain, it takes a holistic approach to responsible farming and is audited annually by accredited, independent third-party certification bodies (CBs).
- Bio-Energy Association Digestate Certification Scheme (under development) – the Bioenergy Association is a New Zealand and Australian group who provide assistance and information to support members' business and promote their expertise and capabilities for undertaking activities in New Zealand, Australian and the South Pacific with regards to bioenergy and biofuels related solutions (Bioenergy Association n.d.). The association are currently developing a standard for digestate with PAS 110 noted as equivalent standard in the UK. Chris Purchas from T+T is on the panel for the development of this standard.

2.5 International regulations and standards

Internationally there are both regulations and standards which provide the basis for producers of soil conditioners, mulches, compostable packaging and labelling of organic goods.

2.5.1 Australia

Standards within Australia include:

- AS4454-2012 AS for Soil Conditioners and Mulches - High level of nutrients and organic matter required to obtain the standard. Must be commercially composted to comply. No reference to PFAS or pesticide parameters. This standard aligns with NZ4454 standard.
- The Australian Certified Organic Standard (ACOS) - Provides the requirements for the labelling of goods which either state or imply they have been produced under organic or bio-dynamic systems. The National Standard includes requirements for production, processing, storage, transportation, labelling and importation of produce and aligns with the requirements of international trading partners, including an annex for the EU requirements.
- AS4736-2006 AS for Commercially Compostable Packaging - Specifies requirements and procedures to determine the 'industrial compostability' (or anaerobic biodegradation), of plastics by addressing biodegradability, disintegration during biological treatment, effect on the biological treatment process and effect on the quality of the resulting compost. This Standard provides a basis to allow labelling of materials or products made from plastics as 'compostable', for use in such facilities as municipal or industrial composters. This Standard applies to the processing of plastics in controlled waste treatment plants.

- AS5810-2010 AS for Home Compostable Packaging - Must be biodegradable over a specified timeframe without being commercially composted. Packaging that has been certified to AS5810-2010 will allow anyone with a home compost system to compost the packaging.

2.5.2 European Union

Legislation within the European Union provides member states direction for their own legislation and regulation around reducing waste to landfill.

- EU Member States – there are a range of implementation tools across Member States and those outside the EU but in the geographical region of Europe.
- 2008/98/EC European Union Waste Framework Directive - Requires member states to progressively reduce the amount of waste being deposited in landfill via individual legislation in each member state (The Council of the European Union 2008). Some EU member states have very low landfill rates through the use of strategic recovery and composting infrastructure, including combustion technologies.
- 1999/31/EC European Union Landfill Directive - Regulates waste management of landfills in the European Union. According to the Directive, the amount of biodegradable municipal waste must be reduced to 50 % in 2009 and to 35 % in 2016 (compared to 1995 levels) (The Council of the European Union 1999).
- Global G.A.P. is also relevant outside of New Zealand and applicable to over 200,000 certificated producers worldwide (Global G.A.P n.d.).
- Member states have various statutory and/or voluntary quality standards and certification schemes in place to meet the requirements of the Framework Directive. The PAS 100 and PAS 110 arrangements in the UK are an example of this.

2.5.3 United Kingdom

In the UK, legislation for organic waste includes that from the EU as well as some specifically for the UK. The specific legislation includes:

- UK Waste Implementation Programme - UK Central Government plan, delivering the action required to meet the UK's legally binding targets under Article Five of the EU Landfill Directive related to reducing levels of biodegradable waste that are landfilled.
- England, Ireland, Wales Publicly Available Specification (PAS) 100 - Publicly Available Specification for Composted Materials (2018), is a widely recognised standard within the organics recycling sector. It contributes to the concept of the circular economy as the base document for the end of waste criteria for compost. Only applies to source-separated organics.
- England, Ireland, Wales Publicly Available Specification (PAS) 110 – Producing Quality Anaerobic Digestate (2014). Developed to clarify the point at which the digestate has ceased to be a waste, thus waste management controls are no longer required, and provide producers and users with confidence that the digestate is fit for purpose. Only applies to source-separated organics.

2.6 Conclusions

Recent central government strategy and existing legislation focus on New Zealand's transition toward a low-emissions and low-waste society. Te Rautaki Para and the Emissions Reduction Plan will both be key to this transition.

In the Waikato the regional policy focus is around reducing waste and viewing any waste that is generated as a resource with value. Local aspirations for waste management and minimisation to align with the region's focus on restoration and protection of the Waikato River for example, organic waste management will not come at the expense of harm to the awa.

The production or use of organic material derived products is largely unregulated in New Zealand. There is no regulatory framework or directive requiring producers to comply with standards. Therefore, any standards which exist are purely voluntary, or specified by the market or New Zealand customers. For example, specifications for the production, processing, storage, transportation and labelling of organic materials derived products.

3 Organic material recovery approaches

The collection, transportation and processing that are used to recover organic materials are described in this section. The approaches discussed for each activity are summarized in Table 3.1.

Table 3.1: Approaches discussed for each activity

Collection	Transportation	Processing
Food only containers	Small bins manually loaded	Vermicomposting
Food and green wheelie bin	Side loader	Static pile composting
Green only wheelie bin	Rear loader	Windrow composting
	Front loader	In-vessel composting
	Milk-run collections	Anaerobic digestion
		Emerging technologies

Section 4 summarises the current situation in the Waikato, Section 5 discusses markets for organic materials based products.

3.1 Collection

In New Zealand, Australia, the UK and Europe, a variety of collection arrangements exist to capture organics at the kerbside from residential and commercial tenements.

In New Zealand wheelie bins (80L – 240L) and food only containers (23L) are used to collect organic materials from the kerbside (Office of the Prime Minister's Chief Science Advisor, 2023). Wheelie bins are predominantly collected via semi or fully automated side loader vehicles while smaller containers may be manually emptied.

In New Zealand, organic materials at a household and commercial scale are generally collected via FO bins, FOGO bins, and green waste only bins (Table 3.2).

Table 3.2: Container types

Food organics	Food and garden organics	Green waste only
 23L FO food only container (ECP Ltd. 2023)	 240L FOGO wheelie bin (Christchurch City Council 2023)	 240L GO wheelie bin (Northland Waste 2023)

Note: FOGO wheelie bins may range from 80L – 240L

3.1.1 Frequency of collection

Food only containers are typically collected weekly. Weekly collection of organics has a number of advantages over less frequent collections, such as giving rise to better nutrient content in any resulting composted materials and a lower risk of the bacteria running out of oxygen and the bin becoming anaerobic (smelly). In addition to odour issues as bins are emptied, anaerobic materials give a poorer quality output of soil amending materials than if the bin remains aerobic and may expose those undertaking the collection to decomposing food and maggots (Craze S. et al. 2014, P. 48).

Typically for standalone residential properties, wheelie bins of 80-240 L are used for the collection of FO, FOGO and GO. GO may be collected weekly, fortnightly or on a monthly basis, while FO and FOGO are generally collected more frequently (weekly or fortnightly).

Small bins can suit the needs of apartments where there is generally less space for storage of bins or containers within the property. In this case emptying of a kitchen caddy of around 7 L size can often mean service users need to take the kitchen caddy to the larger individual or shared bins at ground level. Commercial properties may have daily, multiple collections per week, or a weekly collection.

3.1.2 Aeration vents for FO collections

Wheelie bins and food only containers can be procured which include aeration vents. Vents can be in the body and/or lid of the bin. These are utilised in urban settings across Australia to provide airflow through the bin, which in turn helps to remove water from the contents (reducing weight) and keep the material aerobic. Aeration can also help to prevent unpleasant odours. Recently rolled out FO collections in New Zealand (Auckland, Thames Coromandel) do not include aeration vents.

Kitchen caddies for use inside the home can also be procured with aerated lids and or/bodies, which can further assist by starting the dewatering process earlier than where a non-aerated kitchen caddy is used. There are additional gains to the approach when transport and logistics is factored in. Put simply the least water that needs to be picked up in bins and transported, the better.

3.2 Transportation

3.2.1 Small bins, manually loaded

In this model, organic materials to be captured can be placed in a 23 L food only container, or larger 55-65 L wheelie bin for collection at the kerbside. A small kitchen caddy may be supplied in addition to the food only container. Material is transferred from the kitchen caddy into a larger food only container for collection.

In New Zealand the 23 L food only container is common for FO collections from households (Office of the Prime Minister's Chief Science Advisor, 2023). FO from commercial kitchens or similar operations can also be collected in larger bins (up to 660 L wheelie bins).

The small bin will generally not be large enough to be used as a comingled organics receptable for both food and garden waste. Therefore, this system is most appropriately applied to areas of high-density tenements, where little to no garden waste is requiring capture, or the collection is focused on food only.

FO in 23 L containers will be collected manually, by a loader lifting the food only container into a custom-built containment within a custom-built truck. At the depot, the containment will be unloaded by a forklift truck. Examples of the manual lift of source separated FO onto a custom truck include Hamilton, New Zealand and operations across the UK.

WasteMINZ completed a report in 2020 with recommendations for standardisation of the kerbside collections in Aotearoa which included the recommendation for Councils to adopt a weekly FO collection using 23 L bins (Pritchett & Yates 2020, P. 24).

Typically, two crew members will be required, a loader and a driver. Industry best practice indicates that a side-loader vehicle is preferred, allowing the loader to be protected from traffic impact when loading from the kerbside.

Figure 3-1: Example manual sort collection vehicle (L:Envirowaste NZ 2022), (R: Our Auckland, 2023)

Auckland and Hamilton are examples of areas that uses this type of collection system in New Zealand (Figure 3-1).

Manual handling of materials has safety implications including slips, trips and falls, exposure to traffic and risks of musculoskeletal disorders, particularly if there are repetitive actions such as lifting bins (Craze S. et al. 2014, P. 30, 54). In New Zealand there has been a distinct move away from manual handling of any containers on any waste stream, to reduce safety risks and instil safety in design (WasteMINZ, 2022, p. 104).

3.2.2 Side loader collection

In this model, wheeled bins are collected using automated/ remote lifting systems and the system is most commonly operated by a single operative.

The materials to be captured are placed in an 80-360 L wheelie bin which is dedicated to organics. FOGO in 80-240 L bin and GO in 240 L bins utilise this system in New Zealand. Smaller bins (60 L) are available but can be susceptible to damage from lifting equipment.

There is no evidence to suggest that this system has been adopted to use with kitchen caddies (23-25 L) internationally, or in New Zealand (Craze S. et al. 2014, P. 23). The City of Greater Geelong in Victoria, Australia, is currently using 65 L bins for FO collection trials which are designed to be lifted by side loader vehicles using a single person or two-person crew.

GO and FOGO can be compacted, providing transport efficiencies. Side load vehicles typically provide for the material to be compacted in the vehicle, giving higher collection round efficiency than the stillage type operation.

Side loading collection vehicles are commonly used for FO collections (Craze S. et al. 2014, P. 23). The small bins will generally not be large enough to be used as a comingled organics receptable for FOGO waste.

The safety risk is lower with side loader collections compared to utilising manual handling. In addition to mechanised bin emptying, the material is subsequently unloaded by opening the rear door and raising the collection vehicle hopper, which is an automated process controlled by the driver in the cab whilst the unloading occurs. The driver remains in the cab for all parts of the collection except if a bin needs to be moved for collection/emptying (such as being behind a parked car). For unloading materials, the driver will exit the truck to open the rear door prior to the unloading process commencing.

Figure 3-2 shows a typical side loader vehicle, commonly used in kerbside waste collections utilising bins between 80 L and 360 L in capacity.

Most councils in New Zealand collect municipal waste and recycling this way i.e., the equipment and collection process is well understood.

Figure 3-2: Example sideloader (Rear Vision Solutions n.d.)

3.2.3 Rear loader collection

This operation involves using a collection truck with combs fixed to the rear and a lifting mechanism for emptying bins into a hopper for transfer into the body of the truck. This system is used in relatively few organics kerbside collections due to the need for two or three operatives (driver and one or two ‘runners’ or ‘jockeys’). Other issues include safety risk (manual handling and multiple truck entry and exit events every day) and the slow speed of the operation. This configuration is most appropriate for multi-unit residential developments, mixed use developments, and commercial applications as it can lift the larger 660 L and 1100 L bins and/or where there are height restrictions. Rear load vehicles can also be used for smaller bin collections (120 L and upwards).

This type of system is suited to collecting source separated organics on a larger scale. Figure 3-3 below shows a typical rear loader vehicle.

Figure 3-3: Example rear loader (Waste Management Review 2020)

3.2.4 Front loader collections

This is a system that can be operated by one operative, and is most commonly used in larger commercial applications. Bins of 1.5 m^3 - 4.5 m^3 capacity are utilised and emptied by the vehicle picking up the bin and lifting it over the top of the cab in order to place the contents in a hopper. This operation is most suited to large scale services such as schools, hotels, hospitals, larger commercial premises, and waste transfer stations. A key constraint for this type of service is the need for significant headroom to allow emptying of the bin. This means they are not suitable for underground carparks or areas with overhead power lines or similar constraint. Other risks include bin location, cleaning of the vehicle, manual manoeuvring of bins and the need to remove jammed objects.

Figure 3-4 shows a typical front lift truck operating mid-cycle.

Figure 3-4: Example front loader (Volvo Trucks n.d.)

3.2.5 "Milk run" multi point collection

An operation involving a small collection vehicle such as a van, which isn't a dedicated waste collection vehicle by design, is often referred to as a 'milk run' option. A key characteristic is the swapping of containers rather than emptying containers into a larger container on the vehicle. This operation is often utilised for collection of smaller multiple loads which are some distance away from each other.

It may be necessary to have more than one crew member, depending on the type, weight and size of the containers being used. As manual handling is utilised for large quantities or safety risks need to be carefully managed.

It offers flexibility to suit the scale of the operation in the respect that any vehicle can be used for collections. Collections are not limited to vans or other light vehicles, as seen in Figure 3-5 (Wellington based food scrap collection service Kaicycle). Local collections of organic materials can be completed by bicycle.

Figure 3-5: Kaicycle bicycle food scraps collection set up (Kaicycle, 2022)

3.2.6 Transport to the processing site

The way the agglomerated collected materials reach their final destination for processing differs. The arrangement chosen, either bulk haul or direct haul, is usually based on the distance between the collected materials, the depot the collection vehicles are operated from, and the distance to the disposal/processing site.

Bulk hauling refers to the practise of all collection vehicles returning to their single depot once full, and the material then being lifted via a front-end loader, standard build packing machinery, or custom build packing machinery, into a larger truck for bulk transport. Some examples have a walking floor fitted to maximise efficiency and safety during emptying.

Figure 3-6 shows a b-double vehicle (in Australia) which might be used for transporting liquid or semi-liquid waste materials.

Figure 3-6: Double haulage vehicle for transporting liquid or semi-liquid material (J.J. Richards & Sons Pty Ltd n.d.)

Figure 3-7 shows a typical haulage vehicle which may be used for transporting solid waste such as green waste in large quantities. It utilises containers (may be removable) and requires one driver/operator.

Figure 3-7: Example bulk haulage vehicle for transport of materials (Transfleet Trailers n.d.)

Figure 3-8 shows a custom-built solid waste haulage vehicle which might be used to transport municipal or commercial FO waste. It is packed using custom-built packing equipment to maximise transport efficiency and requires one driver/operator.

Figure 3-8: Example custom solid waste prime mover (Waste Tech 2022)

Direct haul refers to the practice of each individual side loader, rear loader, front lift or milk run vehicles taking their load directly to the processing site as soon as they are fully loaded. The loads are not consolidated therefore this arrangement tends to offer less logistics efficiencies than bulk haulage. However, direct haul is often utilised where there is no transfer station available, the processing site is nearby and/or it is necessary for the trucks to directly transport the materials to the facility on demand.

3.3 Processing

3.3.1 Processing options overview and hierarchy

The 2010 New Zealand Waste Strategy (Ministry for the Environment, 2010) defined organics as, "garden waste, kitchen waste, food process wastes, and sewage sludge". It is possible to adapt the conventional waste hierarchy (reduce, reuse, recycle, recovery) to provide an organic materials processing framework.

The more recent Te rautaki para Waste Strategy (Ministry for the Environment, 2023) does not include a definition of organics, however, the Emissions Reduction Plan defines organic waste as

Wastes containing carbon compounds that are capable of being readily biologically degraded, including by natural processes, such as paper, food residuals, wood wastes, garden and plant wastes, but not inorganic materials such as metals and glass or plastic. Organic wastes can be decomposed by microorganisms into methane, carbon dioxide, nitrous oxide, and simple organic molecules (plastic contains carbon compounds and is theoretically organic in nature, but generally is not readily biodegradable) (Ministry for the Environment, 2022, p. 342).

The framework presented in Figure 3.9 indicates the most preferred to the least preferred option for organics processing. The hierarchy accounts for the processing requirements and outputs via each pathway and is a useful when evaluating options for organics recovery.

The hierarchy addresses an issue particular to organics: high water content. It is uneconomical and poor environmental practice to transport materials with a high water content (almost 70% of average organic materials). Therefore options with no or minimal transportation of organic material feature as the most preferred options for organics management.

The waste hierarchy (Figure 3.9) is used as a guide to prioritise activity, focussing on circular management methods before considering waste management options. Where value cannot be recovered from the materials, or there is no current market for the material the focus is on safe treatment and disposal.

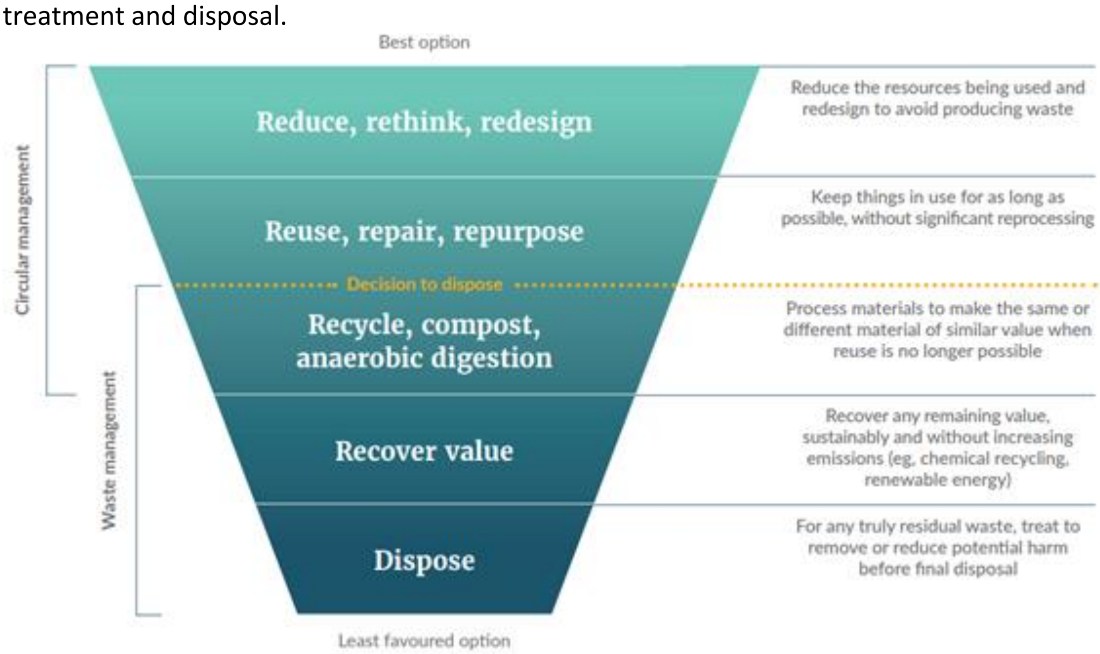


Figure 3.9: The Waste Hierarchy[7]

[7] From the Te rautaki para | Waste Strategy, MfE, 2023 (ME1742).

The organic material recovery and disposal options discussed in the following section are presented in order of preference, reflecting the hierarchy in Figure 3.9. Not all levels of the hierarchy are examined in detail in this report.

Organic materials processing systems produce different end products of varying physical characteristics, quality and potential end market use. Composting output products can be thought of as a range of soil improvers. Many output products from advanced composting systems require processing, transportation, maturation, blending, and screening prior to use.

The nutritional content, structure, moisture retention and other key soil properties differ depending on the inputs and processes used, and therefore the most suitable end market applications differ. The overarching theme is that quality and uncontaminated inputs make the best quality outputs for end market reuse.

3.3.2 Source reduction and home or community composting

The optimal organic materials management strategy is to encourage reduction in organic waste, via education and engagement. This can be complimented by encouraging and supporting individuals to manage their organic waste at home. This takes the onus away from councils providing infrastructure and staff to collect and process materials, and moves towards a circular, local approach utilising education and engagement programs.

Discouraging food waste generation, and supporting home composting, are the two key areas that council can actively support and influence without high-cost investment or infrastructure.

Typically, home and community composting involves small mounds of mixed organic material which are periodically turned manually, similar to small scale windrow compost systems. The quality and amount of output of home compost systems can be improved if a ‘hot compost’ process is used. This depends on the level of engagement, activity and knowledge of those composting. This means that hot composting is less common as it takes more management and thus time. Compost tumblers and multi-chamber systems are available for purchase by households that are designed to improve the composting processing at a household scale.

In some cases, participation is encouraged by councils through subsidising the required equipment. For example, Taupo District Council offers $100 towards establishing home compost systems and other Councils around New Zealand subsidise home composting equipment at varying levels. Online networks such as ShareWaste NZ (https://www.sharewaste.org.nz/share-waste) allow for small scale local networks to be established by connecting individuals wanting to divert their own organic materials to those with capacity in their own home or community composts. These networks are well suited for urban environments where individuals may not be able to establish compost heaps of their own and transport distances are short.

The quality of the compost produced varies; systems require maintenance and management to produce better quality outputs, and inputs vary depending on season, rainfall patterns, and the overall waste generation profile of the households using them.

Home or small-scale community composting produces small quantities of variable quality composted product for reuse, and relies on community/householder intervention and management to be successful. The end market in this case is usually those contributing waste to the system so it offers a circular, local approach.

3.3.3 Vermicomposting

Figure 3-10 New Zealand Vermicomposting Operation (MyNoke, N.D.).

Vermicomposting relies on the use of worms to rapidly breakdown organic material. Vermicomposting can handle a wide range of organic materials but still requires inputs to be monitored and balanced. Vermicomposting can be practiced at a household level with consumer worm bins and DIY systems being available.

The two outputs of vermiculture, liquid (worm tea) and solid (worm castings) are both sought after for their soil amending properties. At a commercial scale, the period for processing material can vary from 12 weeks to 18 months depending on the level of management and period of maturation. Currently large vermicomposting businesses take advantage of substantial available land area, allowing limited movement or management of materials during processing. The worms, feedstock mix and system require careful management to ensure worms remain productive.

Larger green waste from the garden such as logs, branches, grass clippings can't be processed via vermiculture. As a result, vermicomposting and composting are often seen as complimentary processes with each better suited to handle different organic material streams.

The outputs from vermiculture are nutrient dense and have a high moisture content and dense structure. Castings and tea do not require maturation prior to use. They can be used directly on soil, blended, or used to boost the microbial activity in other composting systems.

3.3.4 Static pile composting

Figure 3-11 Static pile composting (Growing for Market 2019)

Conventional static pile composting involves placing the composting mix in 'piles' with composting taking place over a much longer period than turned pile methods. Static pile composting avoids the turning of composting materials to enhance aeration during the initial phase or processing. Aeration occurs through air circulation within the composting mass meaning that selecting a bulking agent that creates air voids is an important consideration. Heat generated by biological activity also creates some air movement through convection.

Aerated static pile composting operations use the same method but with material laid over pipes which either pump air into, or draw air through, the piles. Drawing air through the piles can allow for discharge via biofilter, reducing the release of odour. When air is blown into piles laying a cover of mature compost over new material effectively creates a biofilter for air discharged from the composting pile. Without the need to turn the piles the required the total land area is reduced.

The quality of output materials can be poorer than for windrow or in-vessel composting due to the inconsistency of static pile temperatures and moisture levels leading to variable degradation and stabilisation throughout the pile. This limits the use of output materials as they may require blending with other processed organics to reach accreditation requirements. However this processing approach is straightforward and requires a medium amount of intervention.

Examples of static pile composting in New Zealand include EnviroFert (Tuakau) and Envirowaste (Hampton Downs).

3.3.5 Windrow composting

Figure 3-12 Open Windrow Composting with a specialist windrow turner (Waste Management 2018)

Windrow composting is an aerobic, hot method of composting which breaks down organic materials in around 10-20 weeks. Oxygen is provided to the microorganisms by periodically turning the piles. Windrow operations are limited by the available area and can easily be expanded if space is available. Turning can be achieved using standard earthmoving equipment or specialist compost turners. In contrast to static pile methods, sufficient space for machinery movement is required.

The end product is a quality compost which can be blended and sold to be used in residential gardens or large-scale agriculture. The nutrient content, structure and moisture retention qualities of windrowed material is lower/poorer than in-vessel output material, reflecting limitations on processing some materials. However, the windrow system requires less infrastructure, repairs, monitoring and maintenance than in-vessel composting.

Water management is important, to maintain a suitable moisture content during the composting process and to capture and treat the nutrient rich runoff from the composting area. The risk of odour complaints is also higher with windrow than in-vessel or vermiculture due to the need to turn materials and potential to expose anaerobic (high odour) areas within the windrows.

To maintain a successful windrow compost an equal balance of carbon and nitrogen rich materials needs to be provided. This needs to balance a range of inputs, including nitrogen rich materials (food waste, grass clippings, leaves) and carbon rich bulking agent (woody green waste, wood processing residue, paper). The bulking agent also assists with allowing airflow within the composting mass, improving aeration between turning cycles. The main challenges for windrow composting include managing leachate and odours during operation.

In many jurisdictions, municipal and industrial food waste is generally no longer allowed in windrow composting facilities due to the risk of odour and vermin. Well managed window composting with appropriate buffer distance can process a small proportion of food waste and similar materials with limited odour impacts, however for large scale processing in-vessel processes are likely to be preferred (Refer Section 3.3.6).

Windrow composting offers a relatively simple, medium intervention management system, but produces lower nutrient soil improver products (due to the range of materials that can be processed) and bears a higher risk profile for odour complaints than some other options.

Examples of windrow composting in New Zealand include:

- Waste Management, Tirohia.
- Daltons, Matamata.
- Revital, Cambridge.

3.3.6 In-vessel composting

Figure 3-13: In-vessel Composting System (X-Act Systems N.D.)

In-vessel composting has been used in New Zealand across a wide range of urban and rural settings offering a higher order technology option to basic windrow composting. Examples of in-vessel composting in New Zealand include Innovative Waste Kaikoura.

In typical enclosed systems, semi-automated aerobic hot composting takes place within a controlled environment, and supporting specific bacteria process the organic waste.

Materials are placed within a drum, silo, bag or channel with forced aeration allowing for a high level of automated and/or manual control over the temperature, airflow and moisture content, resulting in initial processing times of around 7-10 days – shorter than basic windrow. Operations can be expanded by introducing more vessels in a modular fashion. The containment and high level of control results in the process being more expensive than other forms of aerobic composting.

In-vessel systems are based on the same principles as windrow composting, with initial composting activity enhanced by the controlled environment. The materials are pasteurised during the initial process due to the high temperatures achieved in-vessel from the microbial activity. Following initial rapid processing materials required 'maturation' before use.

Due to the ability to process high nutrient feedstocks, output materials from in-vessel composting are often superior to those from windrow, including better moisture content and retention, better structure, and better nutrient content. The output products can be used after 4-6 weeks on a maturation pad after in vessel processing. Output materials are more consistently pasteurised and processed when compared to windrow processing, particularly for in-vessel processes that incorporate regular mixing.

Regulatory authorities in the UK and Australia consider in-vessel composting lower risk than basic windrow systems. This is because air emissions are usually biofiltered, emissions are reduced significantly, and the risk of complaints is low. Fully pasteurised materials that are outputted after in-vessel treatment are also pathogen free. This processing system is often used to manage municipal FOGO waste due to its scalability and low complaints profile.

In-vessel composting requires power (usually 3-phase), water, bulking agents and staff to be available on site for adjustments to the process if required. It requires monitoring and control either remotely or in-person by an operator. Some maintenance and repairs are required. The products are less nutrient dense than vermiculture outputs, and typically more nutrient rich than basic windrow composted products (reflecting the ability to process higher nutrient feedstocks). Because materials are contained, getting the feedstock mix is very important with limited opportunity to adjust the mix until the processing is complete.

Examples of in-vessel composting in New Zealand include:

- Extreme Waste, Raglan – a covered channel system with a passive aeration channel with excavator used for turning and moving materials (Horizontal Composting Unit).
- EnviroWaste, Hampton Downs (EnviroWaste) – an enclosed tunnel system with forced aeration (Engineered Composting System).
- Living Earth, Christchurch - an enclosed tunnel system with forced aeration.
- EnviroWaste, Redruth (Timaru) - a Gore systems (aerated bag) system.

3.3.7 Anaerobic digestion

Figure 3-14 Ecogas facility, Reporoa (Ecogas N.D.)

Anaerobic digestion (AD) occurs within a sealed vessel without the presence of oxygen. The process uses different micro-organisms, adapted to an oxygen free environment. The process is generally well suited to higher nitrogen content waste materials and is commonly applied for wastewater solids (municipal and industrial).

In a wet AD process, organic materials in liquid form are fed into vessels to be broken down by microorganisms to produce biogas (a CO_2 and methane mixture) and digestate. The value from anaerobic digestions is predominantly through the sale or use of the biogas. Biogas is often used to heat and condition spaces such as greenhouses but may also be used to generate power. The process is best suited to waste with a very high moisture content. The liquid digestate can be used as a fertiliser in liquid form or dewatered prior to use.

While it is possible to extract some value from the digestate, specialised equipment is required to spread it in large quantities in liquid form which reduces options for use. A wide variety of organic material can be processed by anaerobic digestion however, a relatively consistent supply of similar materials is preferred since rapid changes can disrupt the process. Onsite anaerobic digestion can be well suited for large industrial sites which produce a reliable supply of organic material with a high moisture content such as wastewater solids from the dairy sector. The high moisture content typically limits alternative treatment options and makes transportation difficult.

Digestate from wet AD can be used as a fertiliser for crops, or further processed into specialist chemical products for reuse. Utilising digestate as a fertiliser can reduce chemical fertiliser production, further reducing fossil fuel consumption and CO_2 emissions. Thus, anaerobic digestion can be considered as a key technology to recycle waste into value-added products and fertiliser. Dewatered digestate can be further processed through (aerobic) composting to produce a consumer or general use product.

'Dry anaerobic' systems are also emerging, although they have significantly less track record at a commercial scale. This is a similar process but the input waste has a lower moisture content. Suitable for agricultural waste such as grasses, straw, and silage, as well as livestock manure. In dry digestion systems, solid materials are treated in a batch or plug flow process with liquid recirculated through the digesting materials. The batch process approach is simpler, suitable for small scale operations, and can handle a wider range of materials including non-digestible contaminants but has reduced biogas yield. Plug flow systems are suitable for larger quantities of materials.

Dry AD may offer advantages over wet AD in some situations, such as reduced post-digestate treatment requirements to separate the solids from liquids, and less liquid fraction to treat.

In New Zealand an example of a wet AD system for mixed organic materials is EcoGas (Reporoa) who are developing a wet digestion facility that will accept household food waste alongside similar materials streams.

3.3.8 Emerging technologies

Insect bioconversion including black soldier fly larvae (BSL) is being increasingly recognized as a method for recycling organic materials internationally. The larvae "breakdown various organic wastes using their strong mouth parts and powerful digestive enzymes and effectively decompose organic wastes such as the debris of rotten animals and plants" (Kim C, Et. Al 2021 p.3). While proven internationally, BSL has not been introduced in a New Zealand context. This process would require a separate, FO, collection and careful management of contamination.

3.4 Landfill

Landfilling is often the default end point for unexpected volumes of organic material due to its reliability to be able to accept different volumes, range of material types, and contamination levels. If the cost of landfilling is cheaper than diverting materials to an organics processor, landfilling can also remain the default option for consistent producers of organic material.

Placing organic material in landfills should be avoided as it results in a lost opportunity to produce valuable soil improver products. Organic materials placed in landfill contribute to methane production and associated climate change impacts if the landfill gas is not capture or due to fugitive emissions. Placement of organic materials in landfill also uses valuable airspace, contributing to a reduction in landfill lifespan. There is a limited number of landfills in the Upper North Island meaning transport costs and impacts should also be considered.

While material can only be diverted from landfill if there is a suitable secondary option, recovery of organic materials is likely to increase where:

- There are cost effective options to process/recover organic materials – for example investment like grant funding via the Emissions Reduction and Waste Minimisation Funds.
- Where the gate fee for landfill is high when compared to recovery operations, for example through increasing the disposal cost via the Waste Levy.
- Pricing for the disposal of organic material to landfill is reflected in associated costs for the landfill, particularly noting emissions trading scheme impacts.

It is important to note that for landfill operators there are several aspects to consider with the acceptance of organic materials. For example:

- As organic materials break down in landfill they create landfill gas (methane), creating a liability under the New Zealand Emissions Trading Scheme (ETS).
- ETS liabilities are managed by the capture and flaring of landfill gas. Effective landfill gas management is function of landfill gas generation and the methane content of the gas. This is in turn related to the total degradable material content of waste in the landfill. If the degradable material content is too low there is potential that landfill gas capture and flaring will no longer be viable.
- As organic materials breakdown in landfill their volume reduces, making space available for additional waste. For a landfill operator this means that this space can be used to accept more waste.

3.5 Conclusion

Organic materials may be collected using small bins (predominantly manually loaded), side, rear, or front loader wheelie bin collections systems. The collection methodology will be determined by variables including the property type (commercial, household, muti-unit dwelling), vehicle access and material composition. Kerbside collections using trucks can be complemented by community scale collection systems, utilising different containers and collection methods for example: milk-run collections.

The most preferred options for organics processing are always those with the least intervention such as reducing waste at source. Where organic materials are captured, options for processing include vermicomposting, static pile, windrow and in-vessel composting, anaerobic digestion, and emerging technologies including insect bioconversion. Landfill has been identified as an end point for organic material but is not considered to be a processing option.

4 Current situation in Waikato

4.1 Data collection and analysis

A desktop-based assessment was completed using reports and data provided by Waikato Regional Council that summarise information on organic material in the region supplemented by publicly available desktop information.

Existing information on organic material reviewed included:

- Reports provided:
  - Waikato and Bay of Plenty Region Waste and Recycling Stocktake 2021 (Yates et al. 2021).
  - A mixed-methods study of retail food waste in New Zealand (Goodman-Smith et al. 2020).
- Consent compliance reports.
- Other key information sources:
  - Information provided by commercial/industry waste generators and processors in the region.
  - T+T knowledge of the sector in the Waikato, Auckland and Bay of Plenty Region.
  - T+T knowledge of waste composition from similar regions in New Zealand.
  - Publicly available online data.

Desktop information was supplemented by information provided by commercial/industrial stakeholders during a number of site visits to businesses in the region completed in August 2022.

4.2 Organic material generation

An estimate of the annual production of organic waste from each sector in Waikato and Bay of Plenty is provided in Table 4.1.

The estimates have been calculated by extrapolating data received from industry and online sources. The amounts of waste listed in Table 4.1 do not account for the primary products. For example, in the case of dairy processing the volume excludes milk, cheese and butter sold and instead represents low value material streams such as whey, dissolved air flotation sludge and mother liquor.

The focus of this study is to keep materials in their highest value form. As such, materials with existing end markets were still included due to the possibility for extracting more value from them. One example is the multiple end destinations seen for whey in the dairy industry. Some facilities disposed of whey by discharging onto surrounding pasture while another had partnered with local piggeries to supply the whey as a supplementary source of stockfeed.

Table 4.1: Summary of annual waste generation by sector

Industry Sector	Estimated size within the Waikato and Bay of Plenty (tonnes per year unless otherwise stated)	Commentary
Dairy Processing Factories	Est 750,000 (m^3/year)	
Horticultural packhouses	Unknown	While data was collected from a single kiwifruit and avocado packhouse, extrapolating this data across the many different sectors within the horticultural industry was deemed too uncertain.
Meat and Poultry Processing Factories	Est 100,000	Excludes venison only processors.
Supermarket Waste	Est 10,000	
Residential kerbside food waste	Est 50,000	Based on Yates et al. (2021), noting that only two known food waste collectors were operating in 2020, Xtreme Zero Waste (Raglan) and Hamilton City Council.
Green Waste	>100,000[8]	
Biosolids	Est 100,000+	Moisture content and resulting tonnage varies significantly. Tonnage provided is based on a solids content of 15%[9].
Forestry	Est 110,000+	Based on 18% waste from processing the pulp log fraction of forestry (est 600,000+ tonnes of pulp logs harvested per year) (Haile A et al 2021). The pulp log fraction alone was included as they are often a loss item incurred in the harvesting of more valuable structural timber logs[10]. Even the lowest value products from both pulp and structural timber processing can often be utilised for energy recovery or as a carbon source in composting. Materials sent for energy recovery will produce ash which will require further disposal.
On Farm Organic Waste	Considered out of scope as material remains on farm, biodegrading and returning nutrients to the soil.	

[8] Predicted green waste volumes are from multiple sources including the 2022 Waikato and Bay of Plenty Stocktake. As many commercial operators collect green waste for private businesses or on behalf of councils, some did not wish to disclose their collected volumes due to commercial sensitivity. The stated volume includes the volumes of participating businesses but does not include volumes from Daltons, Tirohia Landfill composting, Kawerau WWTP composting or Hamilton Organic Recycling Centre. Volumes were quantified at end processing facilities as opposed to at intermediate collection points such as transfer stations to reduce the risk of double counting materials.

[9] Based on information provided in discussions with industry.

[10] From conversations with sawmill processors

4.3 Existing collection services

Organic collection services vary across the Waikato and Bay of Plenty regions depending on the type of service required as well as the material types and quantities. Not all areas currently have collection services and those that do are met by a mixture of both public and private sector operators. Typically, the residential kerbside collections are provided by local councils while private businesses tend to meet the needs of other commercial businesses. Due to the cost of transporting organic materials over long distances, competition between collection services across territories is limited. Most operations are located near sites of significant raw material outputs such as cities or primary sector processing plants to reduce transportation.

A summary of organic materials collection services provided by Councils in the Waikato and Bay of Plenty regions is provided in Table 4.2. Auckland Councils recently rolled out food scraps collection has also been included, noting that this material is transported via the Waikato for processing. Examples of other organisations provided collection services are provided in Table 4.3.

In March 2023 MfE announced that food scraps collection services will need to be made available to households in all urban areas by 1 January 2030 (for councils with an existing organics processing facility nearby, food scraps collection services will need to be available by 1 January 2027). Councils may choose whether to provide food scraps only, or FOGO materials collections[11]. At the time of writing, FO collections were preferred by councils in the Waikato (Table 4.2).

[11] At the time of writing (late October 2023, immediately post-election), the priorities of a new Government are unclear. This creates a degree of uncertainty as to the future of central government waste and resource recovery related policy that has been in development to date. While waste and resource recovery initiatives and policy proposals are not necessarily controversial, and generally receive bi-partisan support, the degree to which they are prioritised may change under a new government. However, Te rautaki para I Waste strategy clearly sets out a pathway towards a more circular economy. The timeframes and policy arrangements as indicated to date may change, but there are no signals that focus and direction is likely to be significantly altered by an incoming Government.

Table 4.2: Collection services provided by Councils in the Waikato and Bay of Plenty

District	Council name	Kerbside organics service provided	Material	Frequency and size
Waikato	Hamilton City Council	Yes	Food organics	23 L weekly
	Hauraki District Council	Introduced in 2023		25 L weekly
	Matamata-Piako District Council			
	Otorohanga District Council	No	N/A	N/A
	Rotorua Lakes Council	No – consultation process started in 2022		
	South Waikato District Council	No		
	Taupo District Council			
	Thames-Coromandel District Council	Introduced in 2023	Food organics	25 L weekly
	Waikato District Council	No	N/A	N/A
	Waipa District Council			
	Waitomo District Council			
Bay of plenty	Tauranga City Council	Yes	Food organics and green	Food – 23 L weekly Green – optional fortnightly 240 L
	Kawerau District Council		Green only	240 L fortnightly
	Opotiki District Council	No	N/A	N/A
	Rotorua Lakes Council			
	Taupo District Council			
	Western Bay of Plenty District Council	Yes	Food organics	23 L weekly
	Whakatane District Council		Green only	240 L fortnightly
Auckland	Auckland Council		Food organics	23 L weekly

Table 4.3: Examples of other organic collection

Council area	Provider name	Material	Frequency of collection/type	Size
Waikato District	Xtreme Zero Waste (Council contract)	Food organics	Community Recycling Services & Resource recovery centre	23 L food only container
Hamilton District	Waikato garden bins	Green	Fortnightly, 4 weekly	240 L bin
Hamilton District and beyond	Red lid garden bins and bags		Weekly, fortnightly, 4 weekly, 8 weekly	240 L, 600 L bag
	Green fingers		4 or 8 weekly	240 L, 600 L bag
Waikato District	Waste management			80 L, 140 L, 240 L bin 4 m3, 7 m3, 9 m3 skip bin 1 m3, 2 m3 flexibin
	Greenwaste		Weekly	240 L bin, 600 L bag (weekly or casual), 2 m3 skip bin
	Daisy garden bags and bins		On demand	240 L bin 400 L bag
	Cambridge Hire Bins		On demand	240 L bin
Waikato District	Waikato Garden Bins		Fortnightly or 4 weekly	240 L bin
Tauranga City Tauranga City	JJ Richards & Sons NZ		On demand	120 L, 240 L bin
	JJ's Waste and Recycling	Green and food	Weekly, fortnightly, monthly	120 L, 240 L bin
Tauranga and Rotorua	Bin Boys BOP	Green	4 weekly	120L, 240 L, 660 L, 1100 L bin, 2 m3, 3 m3, 4.5 m3, 6 m3, 9 m3 skips
Tauranga, Mt Maunganui, Waihi, Katikati, Omokoroa, Rotorua	Baycomp Garden Bags		4 weekly and on demand	240 L bin, 600 L bag

Table 4.4: Examples of food bank providers

Council area	Provider name	Material	Frequency of collection/type
Hamilton City	Kaivolution (by Go Eco)	Food	Freestores and distribute through charities
Rotorua District	Love Soup		Distribute to households
South Waikato District	Love Soup		Distribute to households
South Waikato District	Halo Charitable trust		Distribute through community organisations
Western Bay of Plenty District	KaiGo (by Katikati Taiao)		Freestores and distribute through charities

Despite these different models, several factors were repeatedly found to be in place to support the existing collection models:

- Must be convenient for users, hence why provision of kitchen caddies and caddy liners in Australia and other countries where food is collected separately or with garden waste are commonly provided;
- Users need to be incentivised to participate, so always ask 'what's in it for me' from the user standpoint;
- System use should be easy to understand for users so the correct materials are collected and contamination is kept low;
- Ongoing education and engagement for users is a key component in the success of kerbside organic materials collections, in terms of the amount and quality of materials captured, and the contamination rate;
- A lower water content in the collected material is always preferable for transport efficiencies;
- The optimal collection frequency for organic materials is weekly to preserve the nutrient content; and
- The collection frequency of the accompanying kerbside waste service is a critical factor in the success of FO and FOGO collection. Available data suggests higher diversion results can be achieved with fortnightly waste collection.

The overall diversion impact of kerbside organic materials collection services is related to the model chosen. Models ranging from low intervention/impact to high-performance systems are available. The results are reflected in the high diversion rates of councils with high-performance systems. High performance/high engagement FOGO/FO systems usually include:

- Universal provision of a kitchen caddy.
- Provision of or ability to use compostable liners in the kitchen caddy and/or kerbside bin to reduce the cleaning effort required.
- Education and engagement including lid changes to align with relevant colour standards.
- Support for home composters/ vermiculturists, and food waste reduction engagement.
- Provision of a weekly organic materials collection, fortnightly rubbish collections with recycling either weekly or fortnightly.

Lower performance systems may involve much less intervention and therefore capture less organics for recovery. Examples of features that may lead to lower performance include:

- No universal provision of kitchen caddies – for example residents can request them, limited number available.
- No provision or ability to use compostable liners (except newspaper).
- No change to rubbish collection frequency.

4.4 Organic materials processing facilities

A variety of end point facilities are already present in the Waikato and Bay of Plenty regions with their suitability to processing different materials related to the location, type and volumes of available materials. Due to small populations in some areas, there can be a lack of existing end-point facilities resulting in long transport distances from collection to processing facility. Processing facilities available in Auckland have been included, noting their ability to support those already identified in the Waikato and Bay of Plenty regions. The larger scale processing facilities and transfer stations identified are listed in Table 4.5, facilities are grouped by their respective processing technology.

Table 4.5: Identified processing companies within the Waikato and Bay of Plenty

Processing technology	Company name	Accepted materials	District
Aerated Static Pile Composting	Envirofert	Greenwaste, household food waste and wood/timber	Waikato District
	Envirowaste	Food waste, Green Waste	Waikato District
Anaerobic Digestion	EcoGas	Food waste, Sludges, Biosolids	Rotorua District
In-vessel Composting	Xtreme Zero Waste	Greenwaste and food waste	Waikato District
Mulching	Greencycle	Greenwaste	Auckland
Windrow Compost	Daltons	Bark & putrescible waste composting	Matamata-Piako District
	Hamilton Organic Recycling Centre	Greenwaste	Hamilton City
	Kawerau Wastewater treatment plant	Greenwaste	Kawerau District
	Revital	Kitchen Waste, Greenwaste, Kerbside food waste	Waipa District
	Waitoa Industrial Estate	Food waste, Manure, Paunch grass, DAF sludge, Green waste, Sawdust	Matamata-Piako District
	Waste Management NZ Ltd (adjacent to Tirohia Landfill)	Greenwaste and putrescibles	Hauraki District
	Living Earth	Greenwaste	Auckland

Processing technology	Company name	Accepted materials	District
Vermicomposting	EcoCast	Sludges, biosolids, agricultural by-products and other organics	Kawerau District
	Little Buddies	Food waste, Manure	Waipa District
	Mynoke (Maketu)		Western Bay of Plenty
	Mynoke (Taupo)	Food waste, Green Waste, Fibre, Sludges, Biosolids	Taupo District
	Mynoke (Tokoroa)	Fibre, Sludges, Biosolids	South Waikato District
Rendering	Bakels Edible Oils	Animal by-products	Tauranga City
	Waitoa Rendering Plant		Waitoa Industrial Estate
	AFFCO Horotiu		Horotiu
	AFFCO Rangiuru		Rangiuru
Transfer stations	EnviroNZ (3x transfer stations)	Green waste	Hamilton City
	EnviroNZ (Transfer station)		Waipa District
	Otorohanga Recycling Centre		Ōtorohanga District
	Paeroa Refuse Transfer Station		Hauraki District
	Waihi Transfer Station		
	Waste Management NZ Ltd (Transfer station)		Waipa District
	Thames Coromandel sites		Thames Coromandel
	Waste Management NZ Ltd (Transfer station)		Hamilton
	Waste Management NZ Ltd (Transfer station)		Auckland
	EnviroNZ (4x transfer station)		
	Auckland Council		
	Econowaste		
	Heards		

Due to the high moisture content and weight of organic materials, many processing facilities are ideally situated near to large scale organic material producers to reduce freight costs. To identify potential opportunities for the capture of and to maintain the value of organic materials Figure 4-1 to Figure 4-5 illustrate the location of both processors and producers of organic material streams.

Key assumptions:

- Kerbside organic waste: To determine volume and size, a per capita rate was used from the regional waste stocktake (Eve L, et. Al. 2022) and positioned on the largest town or city within each district.
- Supermarket organic waste: To determine volume and size, a per capita rate was used from Goodman-Smith F, et al. 2020. These figures are positioned on the largest town or city within each district.
- Animal products: Due to a lack of information from industry, the combined poultry waste volumes for processing chicken were taken from Mozhiarasi & Natarajan 2022 as 0.68 kg per kg of processed meat. New Zealand has an annual chicken meat production of 220,000 tonnes per year (Poultry Industry Association New Zealand 2022) with Inghams identified as a large scale poultry producer in the region with a 34% market share in NZ (Inghams Group Limited 2016) and a single primary processing which is located in the Waikato (Beef + Lamb New Zealand 2019).
- Animal products: Multiple large scale meat processing plants provided information for this study. To extrapolate the data provided across the remaining gaps in industry, the average waste per stock unit equivalent was determined and multiplied by the processing capability of the non-participating meat processing plants in the Waikato and Bay of Plenty. A list of meat processing sites from Beef and Lamb New Zealand (Beef + Lamb New Zealand 2019) was used to determine the large-scale processors while local butchers were excluded due to their size.
- Forestry: Of the annually harvested 36 million m3 of logs 38% are processed domestically. Around 35% of these domestically processed logs are for pulp and paper (Tirohanga Ngahere Canopy 2022). While forestry has many material streams, pulp and paper logs were considered to be by-products as these are often loss items during the collection of the higher value structural and industrial logs. For example, pulp logs are required to be removed from the forestry site as a consent condition and so they are considered a low value by-product where a higher value use for them would be desirable. The costs associated with collection of these pulp and paper logs is often not recoverable against the value of the product when sold.

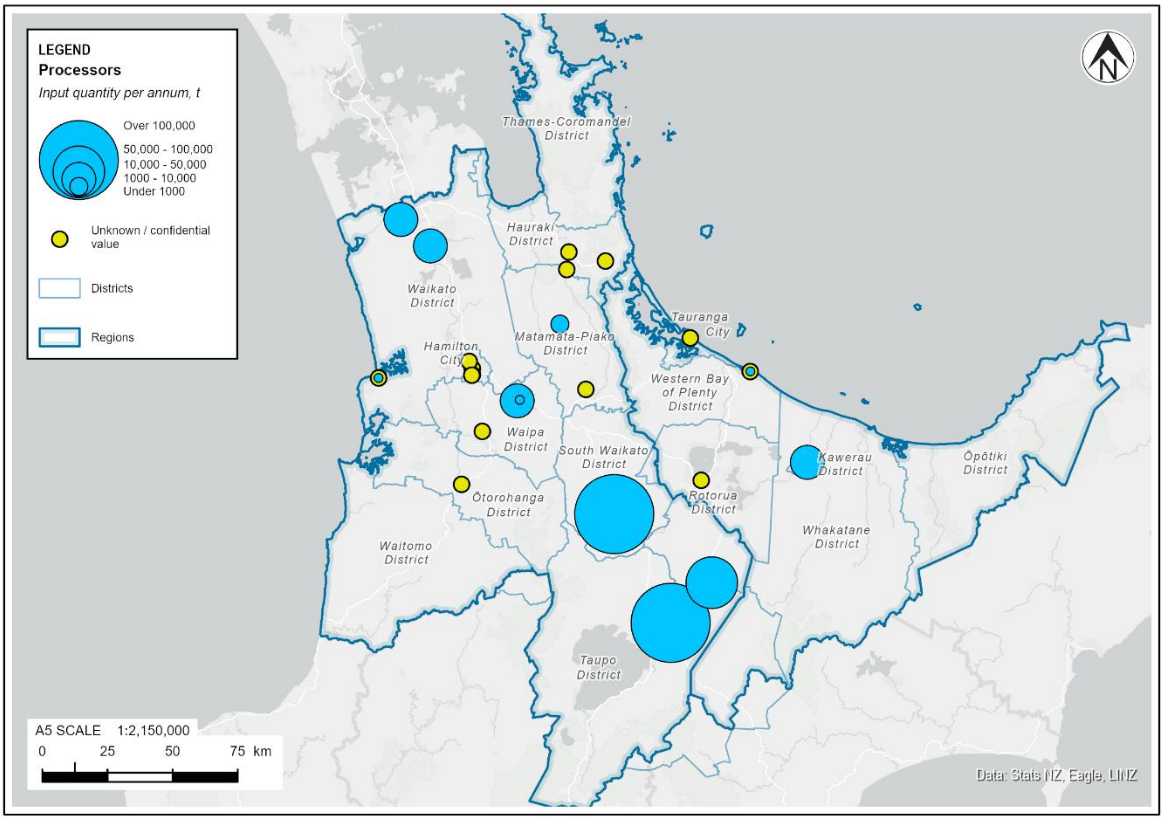


Figure 4-1: Annual processing capacity of identified organic processors within the Waikato and Bay of Plenty (tonnes)

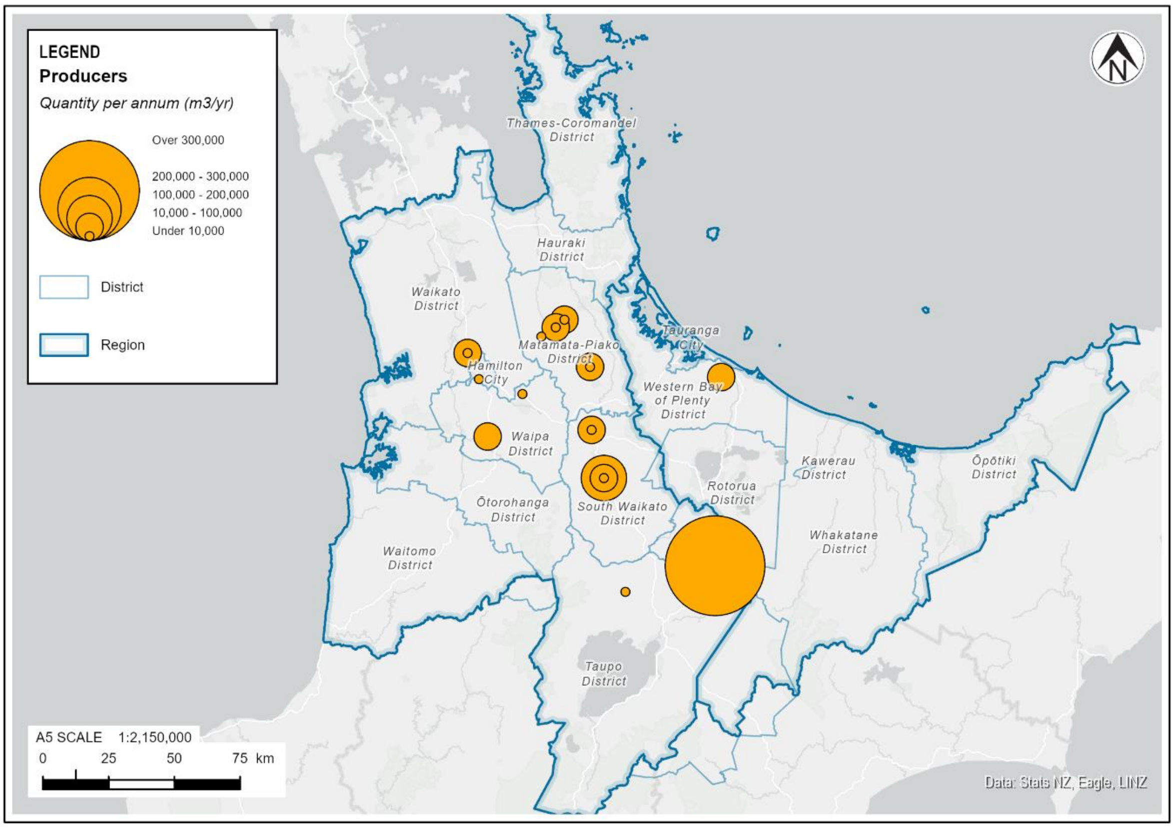


Figure 4-2: Annual waste generation from dairy processors within the Waikato and Bay of Plenty Region (cubic metres)

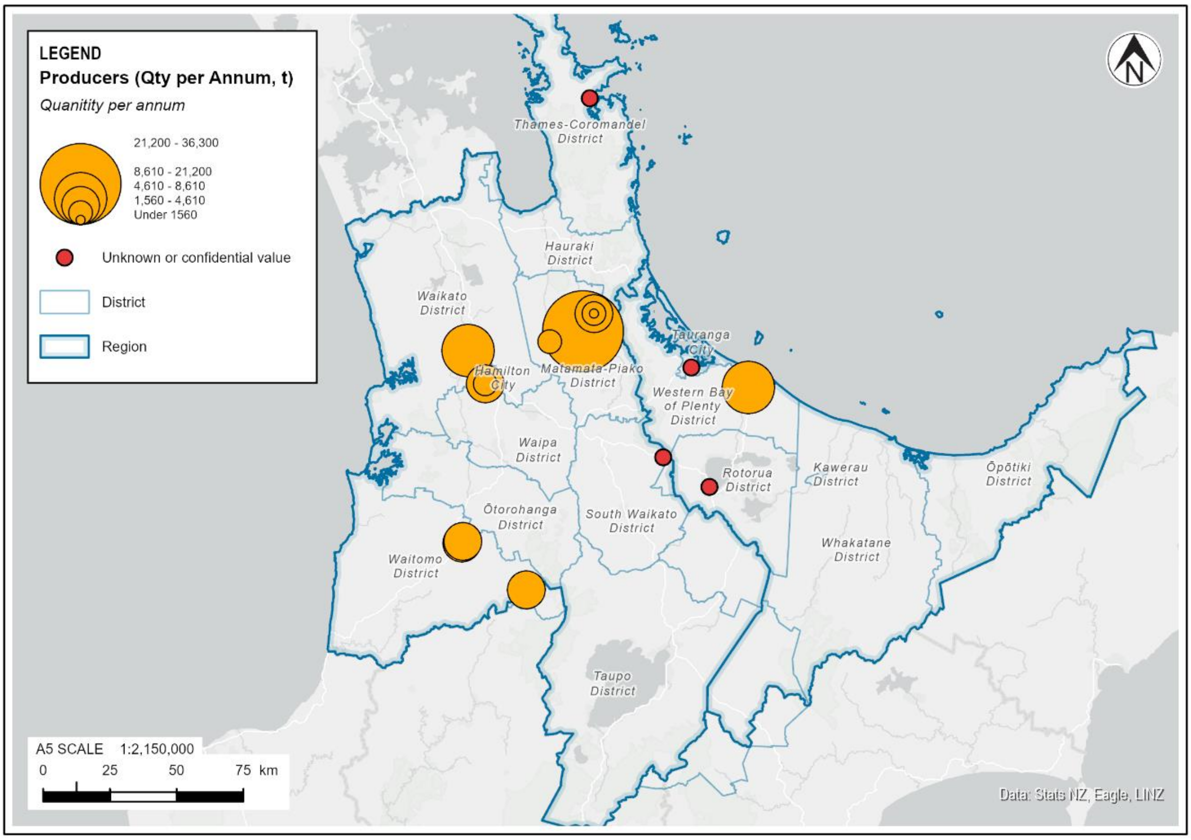


Figure 4-3: Annual waste generation from identified large scale animal processors within the Waikato and Bay of Plenty Region (tonnes)

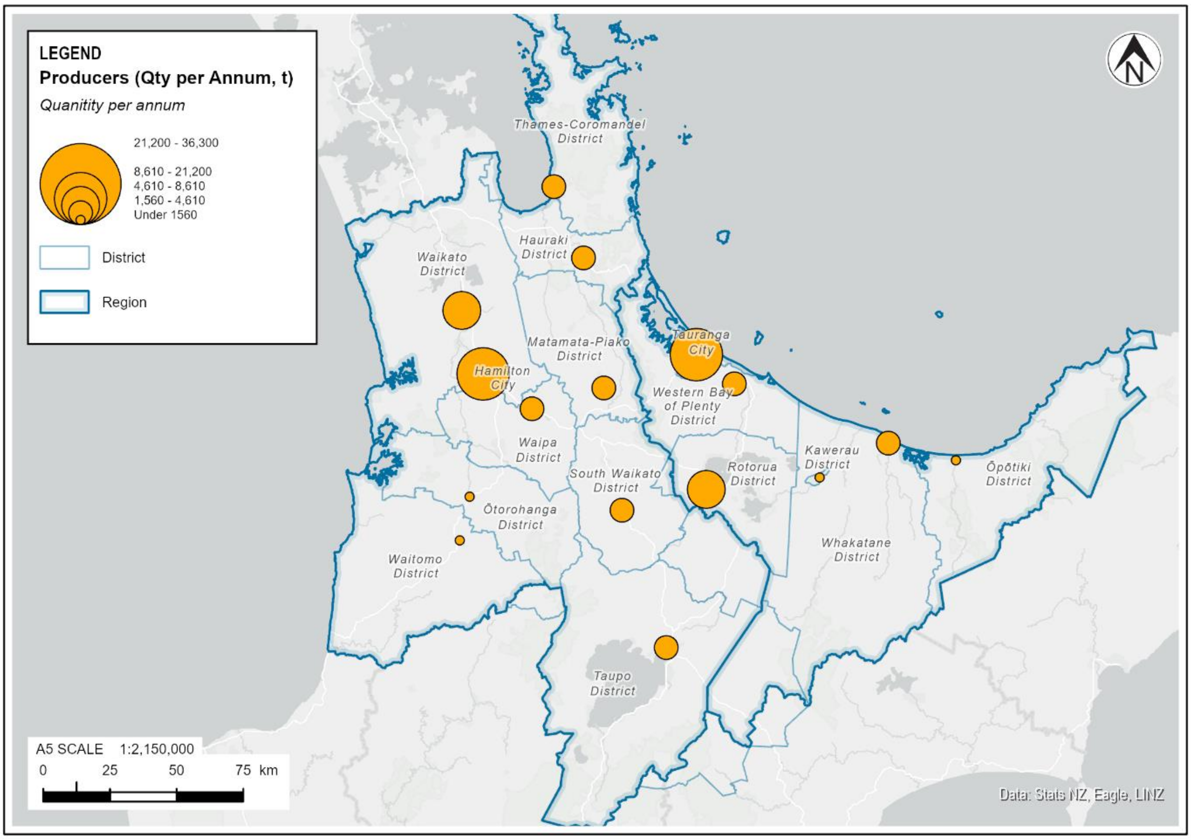


Figure 4-4: Residential kerbside food and green waste produced within the Waikato and Bay of Plenty Region (tonnes)

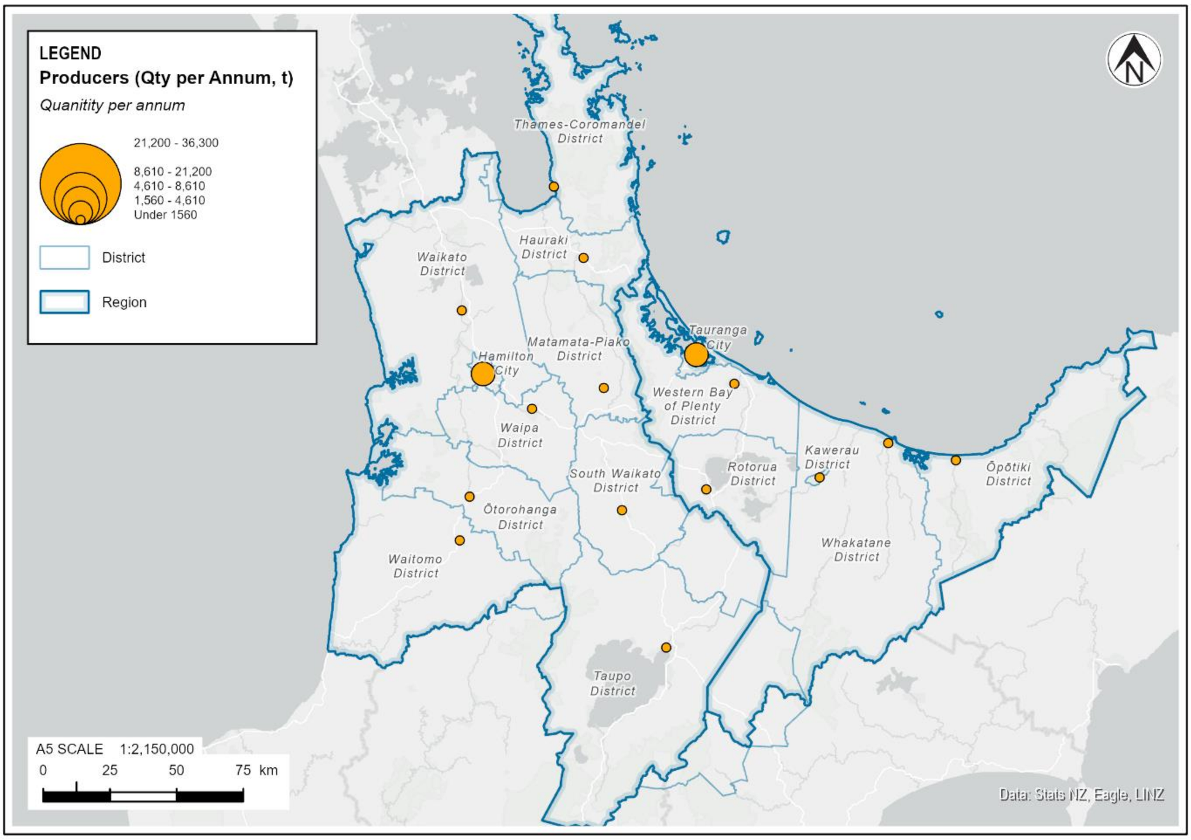


Figure 4-5: Supermarket organic waste produced within the Waikato and Bay of Plenty Region (tonnes)

Large-scale businesses were contacted to participate in the study to understand the current capacity of each processing industry within the Waikato and Bay of Plenty. While not all of the businesses provided information, the values in Table 4.6 represent the identified collective annual processing capacity and product output for several processing methods.

Table 4.6: Collective throughput of identified businesses by processing approach

Processing method	Annual input processing capacity (tonnes per year)	Annual product output capacity (tonnes per year)	Data exceptions
Composting	100,000	70,000	Daltons[12], Tirohia Landfill composting, Kawerau WWTP composting, Hamilton Organic Recycling Centre
Vermicomposting	320,000	80,000	Entire industry within region included
Anaerobic digestion	75,000	70,000	Entire industry within region included
Rendering	Unknown	Unknown	-

[12] While Daltons is a large composting company in the region, their compost is bark based, collected from the logs exported at the port of Tauranga. Therefore, they are not expected to accept large quantities of green waste as a bulking agent.

4.5 Conclusion

Desktop information supported by on-the-ground conversations indicates that there is more than 370,000 tonnes of organic materials per year available in the Waikato at the time of writing. Noting that desktop conversations represent a sample across sectors, given that not all producers of organic waste were contacted.

The type of service required is largely determined by the type and quantity of material generated. Not all areas in the Waikato currently have collection services and those that do, are met by a mixture of both public and private sector operators.

Most processing operations are located near sites of significant raw material outputs such as cities or primary sector processing plants to reduce transportation. This is given that it is uneconomical and poor environmental practice to transport materials with a high water content (almost 70% of average organic materials).

Direction signalled by MfE indicates that by 2030, households in all urban areas will have access to a FO or FOGO kerbside collection. At the time of writing (late October 2023, immediately post-election), the priorities of the new government are unclear. This creates a degree of uncertainty as to the future of the central government waste and resource recovery related policy that has been in development to date.

5 Product end markets

Where organic materials are captured, options for processing can include vermicomposting, static pile, windrow and in-vessel composting, insect bioconversion and anaerobic digestion. This section focuses on products from organic material processing.

5.1 Product benefits

The sale of the end product is essential to the ongoing financial viability of an organic material processing operation. The value and use of the processed organic materials differs substantially depending on the type, location, quality and quantity of materials.

The outputs from the different forms of organic materials processing (for example from aerobic composting, anaerobic digestion and vermiculture) are typically used for their soil amending properties. The specific benefits of utilising the processed organic materials are dependent on the chosen product and their intended use. Table 5.1 outlines some of the key benefits from utilising the processed organic material outputs. The benefits of diverting food waste for human consumption or stock feed have been kept separate as there are significantly different feedstock requirements.

Table 5.1: Material benefit outputs

Material	Key Benefits	References
Compost	• Improved soil structure • Nutrient replacement • Improved moisture retention • Reduced reliance on synthetic fertilisers	Zemánek P., 2011
Anaerobic digestion – liquid digestate	• Note: requires suitable equipment for land application/use • Nutrient replacement	Campos et al. 2019
Anaerobic digestion – dewatered digestate	• Use as feedstock for composting or vermi-composting • Apply directly to land as a dewatered product - similar benefits to compost but may be restricted in where it can be used	
Anaerobic digestion – biogas	• Renewable source of methane and energy • Source of heat and/or power	
Vermicast	• Improved soil structure • Nutrient replacement • Improved moisture retention • Reduced reliance on synthetic fertilisers	MyNoke 2022
Mulch	• Improved moisture retention	Composting NZ 2022
Rendering	• Animal feed, fats (tallow), soil amendment (blood and bone)	
Insect larvae	• Animal feed • Biofuel	Office of the Prime Minister's Chief Science Advisor 2023

5.2 Indicative pricing

As most of these outputs are primarily used for soil improvement, they compete with both each other and other soil amending methods such as manure spreading and synthetic fertilisers. The desired soil amending product depends primarily on the cost of application and benefits of use. A range of prices for outputs from the various processing methods are presented below.

Table 5.2: Outputs - indicative sale prices (September 2022)

Output	Process	Indicative price range (Sept 2022)
Food	Food rescue	Typically donated to charities who collect it for no cost
Stockfeed		Value varies significantly by product and nearby animals
Compost	Windrow, in-vessel or static composting	\$50-90/t[13] \$115/m^3 [14]
Vermicast	Vermicomposting	\$155 - \$215/m^3 [15]
Liquid vermicast extract		\$1,265/m^3 [16]
Methane	Anaerobic Digestion	3.05 c/kWh [17]
Carbon Dioxide		CO_2: \$5/kg [18]
Liquid Digestate		Currently disposed to participating surrounding farms at no charge. Aiming to reclassify digestate as fertiliser and turn into a revenue stream.
Insect larvae	Insect bioconversion	Not established in New Zealand.

5.3 Council use

Research undertaken by Waikato Regional Council identified that restoration planting, council owned assets (sportsgrounds, cemeteries and parks), and community gardens are likely to create a demand for products derived from organic material processing. A number of pre-existing council policies and strategies can enable councils to procure compost, including WMMP, procurement policies, reserve management plans, and Iwi management plans. The procurement of compost by Council can support an 'internal market' where food and/or garden waste within the region is then processed and used by Council. Similar users include other public infrastructure owners (Council Controlled Organisations, Waka Kotahi, Kainga Ora, Ministry of Education.

[13] Discussions with multiple Waikato composters.
[14] Composting New Zealand 2021.Organic Compost.
[15] MyNoke 2022. Earthworm products and organic waste collection.
[16] MyNoke 2022. Earthworm products and organic waste collection.
[17] Ministry of Business, Innovation & Employment 2022.
[18] Eziwap gas industrial gases 2022. Foodgrade (CO2) Full Cylinder.

A key consideration is understanding the requirements for each use and working with the end users to specify suitable products. For example:

- Requirements for parks and reserves - growing media, landscaping, top-dressing for turf.
- Requirements for urban and rural road berms or stabilisation of slopes (erosion and sediment control).

Discussion surrounding other factors that may impact councils procurement of compost are covered in the Circularising Organics: Literature Review prepared as part of this programme.

5.4 Retail

There is an active retail market for compost with bagged and bulk product available from landscaping, garden supplies and hardware retailers across the region. The market for bagged product tends to be dominated by national suppliers (Tui, Daltons, and Living Earth) with bagged product shipped around the country. Own brand products, typically re-branded material from the major players, are often marketed at low prices to attract customers. Bulk compost is also sold by landscaping yards and in some case by compost operations directly.

There is a growing market for vermicast in New Zealand. Vermicast and liquid vermicast extract are available to purchase online, at major retailers and directly from producers. Available quantities range from 1L for a home gardener to 10T for landscaping and topsoil. Discussions with processors established that there is a shortage of product to meet current market demand.

Where materials are sold direct to the public logistics and marketing costs can be avoided.

5.5 Horticulture

Horticulture is an important outlet for compost and soil conditioners across New Zealand. Organic certification has become a de facto standard for this market with BioGro and Assure Quality key certification providers. Further detail on standards can be found in section 2.4 of this report.

Stats NZ Tatauranga Aotearoa (2021) identified 6,305 hectares of horticultural land across Waikato. This was dominated by 1,690 hectares of potatoes, followed by onions (1,520 hectares), asparagus, kiwifruit, blueberries, carrots and apples. Potatoes are known to produce high levels of nitrogen. In the Bay of Plenty 15,362 hectares of land was utilized for horticulture.

Application rates to horticulture crops are dependent on the local soil requirements including limits on maximum nutrient loading. As each compost product has a different nutrient content, the maximum application rates can differ. Two key suppliers within the Waikato region are included in Table , along with their respective recommended application rates.

Table 5.3: Recommended application rates to horticulture

Supplier	Application rates for horticulture
Revital	10 tonnes/hectare (t/ha)
Mynoke (vermicast)	10 t/ha per year, 20 - 50 t/ha for initial application or to replenish soil.

From the supplied application rates the suggested annual market size on horticultural land alone within the Waikato and Bay of Plenty would be approximately 210,000 tonnes of compost with additional market demand for soil replenishment.

Demand for vermicast is variable, noting the variation in application rates for initial application when compared to ongoing application. These values need to considered alongside the use of other sources of nutrients that may contribute to nutrient caps.

In addition to the use of compost as an input for any growing activity, there is potential to use liquid or dewatered digestate for large scale horticulture. This is typically where there are regular opportunities to directly incorporate the material into soil i.e. high rotation crops. An example of this is the use of digestate in vegetable growing in Reporoa.

5.6 Grassland and arable crops

In 2019 there was 27,420 hectares of land used for growing grain and more than one million hectares used for dairy, beef and sheep farming across the Waikato. Similarly, within the Bay of Plenty there was 8,533 hectares of land used for grain production and a combined 178,592 hectares of land used for dairy, beef and sheep production in 2019 (Stats NZ Tataurange Aotearoa, 2021).

The application rates of compost to grasslands can differ from the application rates for horticulture. The recommended application rates to grassland from the same two suppliers have been presented below.

Table 5.4: Application rates to grassland and arable crops

Supplier	Application rates to grassland
Revital	3 – 4 t/ha[19]
Mynoke (vermicast)	10 – 20 t/ha[20]

Similarly to horticulture, the supplied application rates suggest the annual market size for compost and vermicompost to grassland and arable crops within the Waikato and Bay of Plenty would be approximately 3.2 - 4.3 million tonnes of compost or 10.8 – 21.7 million tonnes of vermicast.

5.7 Biofuel

5.7.1 Transport fuels

Bioethanol is made by Fonterra's Anchor Ethanol plants using whey (New Zealand Forest Research Institute Limited, 2018). Numerous NZ companies are interested in or are exploring the option of transport biofuels (including Z Energy, Norske, Air New Zealand, Futurity and KiwiRail). Feedstocks include whey (to produce ethanol for blending with petrol), waste cooking oil, virgin plant oil and tallow (to produce biodiesel). Fats derived from insects used in insect bioconversion also present an alternative input for biofuel production given their high lipid content (Kim C, Et. Al 2021 p.12).

International sustainable aviation fuel is produced from organic materials and other wastes with subsequent refining to produce the high quality fuel required for aviation purposes.

[19] Revital Fetilisers (n.dd.). Revital compost 50. https://revital.co.nz/wp-content/themes/suite/pdf/REVITAL_COMPOST_50.pdf (accessed September 2022).
[20] MyNoke 2022. Frequently asked questions. https://www.mynoke.co.nz/faq (accessed September 2022).

5.7.2 Industrial heat

Forest residues, organic municipal solid waste and waste wood can be used to create biofuel. There is an active market in wood waste and wood chip for use in biofuel boilers in the Waikato and Bay of Plenty. Black liquor (from wood pulping) is used in industrial boilers at pulp and paper sites at Kinleith and Kawerau. Other wood processors use wood waste (sawdust, shavings) to generate steam and in some cases power. Examples including wood processing sites in Tokoroa, Hamilton and Rotorua.

Markets are emerging and developing to increase the value of existing biofuel streams and meet the growing number of operational biofuel boilers. Examples include transitioning from the combustion of sawdust to compressing sawdust into wood pellets. Wood pellets are also used in domestic and small commercial boilers (such as schools). The growing number of biofuel boilers reflects a range of industrial heat users converting coal and gas boilers into biofuel boilers as part of their decarbonisation process.

5.8 Stockfeed

Feeding unwanted organic materials to stock can range in size from small scale food waste being processed for chicken feed to large commercial piggeries and commercial food recovery to stockfeed processors. Utilising suitable organics as stockfeed is a high value use of the organic material.

Feed for pigs is regulated as per the Biosecurity (Meat and Food Waste for Pigs) Regulation 2005. These regulations stipulate that pigs must not be fed untreated meat or untreated food waste. As per the regulation 'untreated food waste' includes untreated meat and food waste which has come into contact with other food waste that is or contains untreated meat. The regulation and MPI state the requirements for treating food waste.

Primary suppliers of organic materials suitable for stockfeed include supermarkets and horticulture businesses. Rapid collection and/or appropriate storage is required to ensure the organic materials arrive in a suitable condition to feed to stock. Contamination is a significant concern for recipients of diverted stockfeed, typically due to plastic packaging.

Rendering also produces material suitable for animal feed. Insect bioconversion has been proven as a stock feed internationally, how this may fit within a New Zealand context is not yet understood.

5.9 Conclusion

Where organic materials are captured, options for processing include vermicomposting, static pile, windrow and in-vessel composting, and anaerobic digestion. The value and use of the processed organic materials differs depending on the type, location, quality and quantity of materials. The sale of the end product is essential to the ongoing financial viability of an organic material processing operation.

Markets are emerging for bio-fuel and digestate. Markets currently established soil amendments include council use, retail, horticulture, and grassland and arable crops.

6 Review of regional barriers and opportunities

6.1 Shortage of input materials

The processing market is expanding. New processors are entering the space and existing processors are currently establishing, or looking for, new locations. There is a general shortage of inputs such as green waste to meet the required demand for compost[21]. Some processors believe they have captured all available and suitable materials within their available area. In these cases, additional sites are being proposed and/or developed to cover new areas to secure additional suitable feedstock.

6.2 Variable market perception of compost products

Processors spoken to as part of this project advised us that that the combination of public perception, increasing landfill costs and demand for outputs have resulted in a large opportunity to grow. The growing demand for the soil amending outputs from organic materials processors is largely due to an industry desire to find alternatives to synthetic fertilisers and weed control products. Different users of organic materials derived products are understood to be at different stages of valuing these alternative soil amenders.

Horticulture is believed to understand the additional benefits of compost such as moisture retention and weed control more than agriculture. This means that they are the primary purchasers of soil amending products. For example, the sector understand that use of compost around kiwifruit vines provides multiple benefits (moisture retention, weed suppression, soil improvement). This means quality product attracts a good price when used in the horticulture sector.

6.3 Markets for digestate are emerging in New Zealand

As it stands, digestate is not classified as a fertiliser and therefore applied to farms that surround the facility for no charge. The New Zealand Bioenergy Association is working toward the adoption of internationally recognised standards, protocols and procedures to establish a methodology for classification and certification of all digestate from anaerobic digestion (Bioenergy Association, 2022 p. 1). It has been acknowledged that the use of digestate as biofertiliser has been limited by the perception of being unsafe due to its origin from waste materials and/or animal by-products. Regulation of digestate and technical specifications and are hoped to provide confidence in the supply of high-quality, safe and healthy digestate for use as a fertiliser substitute.

[21] From discussions with a sample of processing businesses within the region.

Markets for biofuel and outputs from emerging technologies are similarly limited by the perception of being unproven and unregulated in New Zealand. However, research has established that biofuels are a technologically and economically viable option that could be utilised to reduce transport emissions, while we transition to a low-emissions transport system (Comendant & Stevenson, 2021 p.2).

6.4 Variable approach to scale and locations

There are numerous established large-scale processors in the region who can collect or accept bulk volumes of organic material for processing. As noted above, some processors are considering establishing in new areas to secure additional suitable feedstock. In many cases processors require a significant minimum volume to make materials collection and processing economic.

An emergence of intermediate sized companies who are looking to partner with unwanted organic material producers was seen. By partnering with producers, these intermediate sized companies are attempting to capture materials which may be underutilised by the large-scale processors.

With new technology becoming available at scale there are multiple processing options available for most materials. Transport distance was noted as significant constraint.

The range of soil improver products produced is broad and their application varies. This is discussed in detail in Section 5. The variation is due to the wide range of input products, the processing system used to recover the recycled organics and the addition of further soil improvers.

6.5 Quality products rely on quality inputs

When assessing the recovery and reuse options for organic materials, viability comes back to the end market opportunities. Quality product is a critical cornerstone to build confidence in the end market. To do this, it is essential to ensure quality processing inputs with low or no contamination, and appropriate processes to remove contamination and process the organic materials correctly to be able to achieve high-quality end products.

6.6 The public sector as a key market

Once the quality and reliability of composted products is established, council can consider buy-back options to achieve full circularity of their own organic materials. Examples include using recovered products on parks, gardens, road verges, and in horticultural applications.

The remainder of Section 6 summarises barriers and opportunities identified in discussion with industry stakeholders. The notable points have been grouped by topics around inputs, outputs and barriers and opportunities.

6.7 Composting barriers and opportunities

Key insights from discussion with composters are noted in Table 6.1.

Table 6.1: Compost processor insights summary

Topic	Insights
Inputs	• There is a shortage of large-quantities of input materials to meet the current demand for compost products. • Composting can be complementary with other processing systems such as vermicomposting to improve resilience to variability in material content and shock loads. • Each site is designed alongside parameters such as available space, infrastructure capex and proximity to people. • Processing time can range from 12 weeks to 8 months depending on processing methods and maturation times. For example: - Xtreme Zero Waste: 12 weeks (in vessel composting + maturation). - Revital: 8 months (windrow composting).
Outputs	• Product value depends on input materials, levels of contaminants and if value adding additions or processing occurs. • It was noted that there was a larger demand for compost products by the horticulture industry than pastoral agriculture. This was believed to be due to horticulturists having a higher appreciation for soil structure and wider benefits of compost use. • Some believe the issue of leachate management (during processing) can be solved by rotating windrow sites, investing in capital and correctly balancing the mixture of material inputs. • There is a shortage of product to meet current market demand.
Barriers and Opportunities	• Contamination which reduces the value of outputs can be an issue. Progress can be slow to remove contamination (PLA, PFAS in biodegradable food ware, orchard plastics, sprays and herbicides). • Physical contamination removal through screening is seen to be part of the solution to reducing contamination in products. • Testing for chemical residues is also used to identify contamination. • Since the ban on single use bags, contamination has reduced.

6.8 Vermicomposting barriers and opportunities

Key insights from discussion with vermi-composters are noted in Table 6.2.

Table 6.2: Vermi-composter insights summary

Topic	Insights

Inputs	• There is a shortage of large-scale input materials to meet the current demand for vermicomposting products.
	• Vermicomposting has the capability to process most organic streams for example:
	  - Ash
	  - Waste activated sludge
	  - Dissolved air flotation sludge
	  - Biosolids
	  - Manure
	• Establishing effective logistics is important.
	• Vermicomposting as a system can be complementary with other processing systems such as composting to improve resilience to variety in material content and shock loads.
	• The processing time can range from 12 weeks to 18 months depending on pre-processing methods and maturation time, examples include:
	  - Little buddies – 16 weeks (in vessel vermicomposting).
	  - Mynoke – 12 months (windrow vermicomposting).
	  - Ecocast – 18 months (windrow vermicomposting).
	• Large plastics and other contaminants can be screened out at the final stage. Partnering with organic material suppliers providing the input materials can reduce contamination.
	• Each site is designed with factors such as available space, capex for infrastructure and proximity to people in mind.

Outputs	• Product value depends on input materials, levels of contaminants and if value adding additions or processing occurs. • It was noted that there was a larger demand for vermi-compost products by the horticulture industry than agriculture. • There is a shortage of product to meet current market demand.
Barriers and Opportunities	• Gaining resource consent was highlighted as the most prominent hurdle facing businesses looking to expand their operations. • An opportunity to develop a standardised application procedure (similar to composting) for a currently unique application. This would be supported by the track record which companies are beginning to establish. • Since the ban on single use bags, contamination has reduced.

6.9 Anaerobic Digestion barriers and opportunities

The following information was provided by EcoGas. They are currently developing a site that will accept mixed organic materials in New Zealand. Other anaerobic digestion infrastructure is present within the region at processing plants for meat and dairy. However, these additional facilities are used solely for the treatment of materials produced onsite.

Table 6.3: Anaerobic digestion insights summary

Topic	Insights
Inputs	• Waste sources include: household, supermarkets, grease traps and dairy. • Does not accept abattoir waste, as this introduces complexities with gaining consent. • Approximately two thirds of material input is food waste from Auckland and one third is regional industry waste. • Trucks transporting aggregate to Auckland which are currently returning empty are utilised to lower the cost and environmental impact of transporting food waste from Auckland, • Preference for fat over protein and carbohydrate inputs due to higher gas yields, • Have a single layer de-packaging system on site • No dewatering processing occurring, advised as a lack of return on investment.
Outputs	• Approximately 100,000GJ of gas will be exported to the network annually (after onsite power and supply to neighbouring tomato greenhouses is extracted). • Approximately 60,000t of digestate will be produced annually, which is spread on surrounding farms (approximately 1,200ha – 1,500ha). • Renewable source of carbon dioxide which can be used in greenhouses and food industry. • For every 200 tonnes of input will produce approximately 185t of output (digestate). New Zealand currently allows irrigation during winter, while this is banned in some places overseas due to leaching potential.
Barriers and Opportunities	• Largest barrier is the continual removal of digestate. • Specialised equipment will be required for application to land of digestate to reduce volatising. • Microplastics and chemical contamination are still an issue and there is limited ability to control other than through depackaging upfront and testing. • Certification of digestate as a biofertilizer will reduce the restrictions on application to land. This is the subject of a BioEnergy Association of New Zealand project, part funded by the Waste Minimisation Fund.

7 Applicability

This report has been prepared for the exclusive use of our client Waikato Regional Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Appendix A - Reference list

Asure Quality 2020. AsureQuality Organic Standard. Auckland. AsureQuality Limited.

Beef + Lamb New Zealand 2019. Meat Processing in New Zealand. Meat processors in NZ - May 2019.pdf (beeflambnz.com) (accessed October 2022).

Bioenergy Association 2022. Establishment of a Biofertiliser Certification Scheme. https://www.bioenergy.org.nz/resource/biofertiliser-certification-scheme (accessed October 2022).

Bioenergy Association 2022. Project: Programme to avoid digestate disposal to landfill - Securing beneficial use of digestate via biofertiliser certification p.1

Biogro n.d. Organic Certification. https://www.biogro.co.nz/organic-certification-programmes (accessed October 2022).

British Standards Institution 2014. BSI PAS 110: Producing Quality Anaerobic Digestate. British Standards Institute.

British Standards Institution 2018. BSI PAS 100: Publicly Available Specification: Specification for composted materials. British Standards Institute.

Campos, J. Crutchik, D., Franchi, O., Pavissich, J.P, Belmonte, M., Pedrouso, A. Mosquera-Corral, A., Val del Rio, A. 2019. Nitrogen and Phosphorus Recovery From Anaerobically Pretreated Agro-Food Wastes: A Review. Frontiers in Sustainable Food Systems. https://www.frontiersin.org/articles/10.3389/fsufs.2018.00091

Comendant C, Stevenson T 2021. Biofuel Insights – An independent report prepared for EECA p.2

Composting New Zealand 2021. Organic Compost. https://wairarapa.compostingnz.co.nz/product/organic-compost/?_ga=2.158602746.1139498241.1663195480-812901102.1662934133 (accessed September 2022).

Composting New Zealand 2022. Mulching: A Complete Guide. https://compostingnz.co.nz/everything-you-ever-needed-to-know-about-mulching/

Craze S, Wilde S, Drewitt T, Clarke B, Perrin D 2014. Review of H&S Hazards and Risks for Different Food Waste Collection Systems. Prepared for Auckland Council. Auckland. (Unpublished report held by Auckland Council).

Department of Internal Affairs 2023. Local Government Act 2002. Prepared for the New Zealand Government. Wellington. New Zealand Government.

Ellen McArthur Foundation 2022: Circular products and materials. Circular economy principle: Circulate products and materials (ellenmacarthurfoundation.org) (accessed 1 October 2022).

Envirowaste NZ 2019. Sea EV Refuse Truck. https://www.sea-electric.com/products/refuse-ev/ (accessed June 2023).

Eve L, van Gool E, Wilson D, Middleton B, Yates S 2022. Waikato and Bay of Plenty region waste and recycling stocktake 2021. Prepared for Waikato Regional Council. (Unpublished report held by Waikato Regional Council).

Eziwap gas industrial gases 2022. Foodgrade (CO2) Full Cylinder. https://eziswapgas.co.nz/co2-2 (accessed September 2022).

Global G.A.P n.d. GLOBALG.A.P. Certification. https://www.globalgap.org/uk_en/what-we-do/globalg.a.p.-certification/ (accessed October 2022).

Goodman-Smith F, et al. 2020. A mixed-methods study of retail food waste in New Zealand. A mixed-methods study of retail food waste in New Zealand (accessed October 2022).

Guardians Establishment Committee 2019. Restoring and protecting the health and wellbeing of the Waikato River. (Unpublished report held by the Waikato River Authority).

Haile A, Gelebo GG, Tesfaye T, Mengie W, Mebrate MA, Abuhay A, Limeneh DY 2021. https://bioresourcesbioprocessing.springeropen.com/articles/10.1186/s40643-021-00385-3 (accessed October 2022).

He Pou a Rangi - Climate Change Commission 2021. Ināia tonu nei: a low emissions future for Aotearoa. Ināia tonu nei: a low emissions future for Aotearoa (climatecommission.govt.nz) (accessed October 2022).

Inghams Group Limited 2016. Inghams prospectus Initial Public Offering of Ordinary Shares. Inghams prospectus Initial Public Offering of Ordinary Shares (accessed October 2022)

Inghams Limited 2022. Our Network. https://inghams.com.au/our-company/network/ (accessed September 2022).

J.J. Richards & Sons Pty Ltd n.d. Image Gallery. https://www.jjrichards.com.au/gallery/fleet/ (accessed October 2022).

Kaicycle n.d. Kaicycle Composting. https://kaicycle.org.nz/our-services (accessed October 2022).

Kim, C.-H.; Ryu, J.; Lee, J.;Ko, K.; Lee, J.-y.; Park, K.Y.; Chung, H. 2021. Use of Black Soldier Fly Larvae for Food Waste Treatment and Energy Production in Asian Countries: A Review.

Kupa, S. & Smith V. 2007. Waikato regional waste infrastructure stocktake and strategic assessment. Prepared for Environment Waikato. Hamilton East. (Unpublished report held by Waikato Regional Council).

Ministry for Primary Industries Manato Ahu Matua 2022. Protect New Zealand – don't feed pigs untreated meat waste. https://www.mpi.govt.nz/animals/animal-feed-preventing-disease-transfer/feeding-food-waste-to-pigs-and-preventing-disease/ (accessed September 2022).

Ministry for the Environment 2010. The New Zealand Waste Strategy: Reducing harm, improving efficiency. Prepared for the New Zealand Government. Wellington. New Zealand Government.

Ministry for the Environment 2021. Waste Minimisation Act 2008. Prepared for New Zealand Government. Wellington. New Zealand Government.

Ministry for the Environment 2022. Te hau mārohi ki anamata | Towards a productive, sustainable and inclusive economy. Prepared for the New Zealand Government. Wellington. New Zealand Government.

Ministry for the Environment 2023. Climate Change Response Act 2002. Prepared for the New Zealand Government. Wellington. New Zealand Government.

Ministry for the Environment 2023. Resource Management Act 1991 (under review). Prepared for the New Zealand Government. Wellington. New Zealand Government.

Ministry for the Environment 2023. Te rautaki para | Waste strategy. Aotearoa New Zealand Waste Strategy | Ministry for the Environment (accessed May 2023) p.18.

Ministry of Business, Innovation & Employment 2022. Energy prices. https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/energy-prices/ (accessed September 2022).

Mozhiarasi V, Natarajan TS 2022. Slaughterhouse and poultry wastes: management practices, feedstocks for renewable energy production, and recovery of value added products. Slaughterhouse and poultry wastes: management practices, feedstocks for renewable energy production, and recovery of value added products (springer.com) (accessed October 2022).

MyNoke 2022. Earthworm products and organic waste collection. https://shop.mynoke.co.nz/#products (accessed September 2022).

MyNoke 2022. Earthworm products and organic waste collection. https://shop.mynoke.co.nz/product/liquid-vermicast-extract-1000-litres-price-incl-refundable-drum/ (accessed September 2022).

MyNoke 2022. Frequently asked questions. https://www.mynoke.co.nz/faq (accessed September 2022).

National Institute of Water and Atmospheric Research Ltd 2010. Waikato River Independent Scoping Study, Appendix 13: Water Quality. Hamilton. National Institute of Water and Atmospheric Research Ltd.

New Zealand Forest Research Institute Limited 2018. New Zealand Biofuels Roadmap Summary Report. Growing a biofueled New Zealand. Rotorua, Scion.

Norris M, Borman D, Hill R 2021. Waikato Prioritisation Framework and its use for soil conservation - development and methods. Prepared for Waikato Regional Council. Hamilton. (Unpublished report held by Waikato Regional Council).

Office of the Prime Minister’s Chief Science Advisor 2023. Processing food waste at large scales. https://www.pmcsa.ac.nz/topics/food-rescue-food-waste/what-can-i-do-with-my-food-waste/processing-food-waste-at-large-scales/ (accessed December 2023).

Poultry Industry Association New Zealand 2022. NZ chicken meat and poultry production and consumption show continuing increases. NZ chicken meat and poultry production and consumption show continuing increases | Poultry Industry Association New Zealand (pianz.org.nz) (accessed September 2022).

Pritchett & Yates, Sunshine Yates Consulting 2020. Recommendations for standardisation of kerbside collections in Aotearoa. A report prepared for Ministry for the Environment by WasteMINZ. Recommendations for standardisation of kerbside collections in Aotearoa (environment.govt.nz) (accessed October 2022)

Rear Vision Systems n.d. Waste | Solutions. https://www.rearvisionsystems.com.au/solutions/waste (accessed October 2022).

Revital Fertilisers (n.dd.). Revital compost 50. https://revital.co.nz/wp-content/themes/suite/pdf/REVITAL_COMPOST_50.pdf (accessed September 2022).

Smith V, 2007. Waikato regional waste infrastructure stocktake and strategic assessment. Prepared for Environment Waikato. Hamilton East. (Unpublished report held by Waikato Regional Council).

Standards New Zealand 2005. NZS 4454:2005 Organic Production.

Stats NZ Tatauranga Aotearoa 2021. Agricultural and historical land use Agricultural and horticultural land use | Stats NZ (accessed September 2022).

Stats NZ Tatauranga Aotearoa 2021. Agricultural and historical land use. Agricultural and historical land use (accessed September 2022).

The Council of the European Union 1999. Council Directive 1999/31EC of 26 April 1999 on the landfill of waste. Official Journal of the European Communities.

The Council of the European Union 2008. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Official Journal of the European Union.

Transfleet Trailers n.d. Clip Chip heavy duty panel bulk refuse equipment. https://www.transfleet.co.nz/clip_chip_heavy_duty_panel_bulk_refuse_equipment.cfm (accessed October 2022).

Trohanga Ngahere Canopy 2022. The New Zealand log market. https://www.canopy.govt.nz/market-forest/new-zealand-log-market/ (accessed September 2022).

Volvo Trucks n.d. Australia's best waste trucks. https://www.volvotrucks.com.au/en-au/trucks/trucks/waste.html (accessed October 2022).

Waikato Economic Impact Joint Venture 2014. A tool for freshwater nutrient management in the Waikato-Waipa catchment. (Unpublished report held by Waikato Regional Council and Ministry for Primary Industries).

Waikato Regional Council 2021. 2021 - 2031 Long Term Plan | Mahere Whānui. Hamilton. (Unpublished report held by Waikato Regional Council).

Waikato Regional Council 2021. Waikato Regional Plan. Hamilton. Waikato Regional Council.

WasteMINZ, 2022. Health and Safety Guidelines: for the Solid Waste and Resource Recovery Sector – parts one, two, three, four and five. P. 104.

Waste Management Review 2020. The hydraulic compaction model: Hyva Equipment. https://wastemanagementreview.com.au/the-hydraulic-compaction-model-hyva-equipment/ (accessed October 2022).

Waste Tech 2022. Gallery. https://wastech.com.au/gwts-gallery/transfer-trailers/ (accessed October 2022).

Zemánek P., 2011. Evaluation of compost influence on soil water retention. 30_zemanek_3_aj.indd (climecointernational.com)

Appendix B - Analysis of existing regulations

Appendix B Table 1: Relevant regulations, standards and guidance within New Zealand

Regulations/ Standard/ Guidance	Implementation body	Comment
Waikato Regional rules (nitrogen limits & composting activities)	Local Government *Mandatory*	Chapter 3 – Water **3.5 – Discharges** 3.5.6 Implementation Methods – discharge of biosolids and sludges or liquids from activated sludge treatment processes to land 3.5.6.3 – Controlled activity Discharge of Biosolids and Sludges and Liquids from Activated Sludge Treatment Processes. Waikato Regional Council reserves control over the following matters: (xii) record keeping and nutrient budgeting. **3.9 – Non-Point Source Discharges**[22] 3.9.4 – Implementation Methods – Non-Point Source Discharges 3.9.4.11 – Permitted Activity Rule – Fertiliser Application The discharge of fertiliser into air and onto or into land outside the Lake Taupo Catchment is a permitted activity subject to conditions (d) and (e). These conditions state a nutrient management plan must be developed, provided to Waikato Regional Council and used to plan fertiliser application where nitrogen fertiliser is being applied at rates greater than 60 kg/N/ha/year (kilogram of nitrogen per hectare per year. 3.9.7 – Guidance Notes for the use of Fertiliser Rule 3.9.4.11 is only applicable to land outside of the Lake Taupo catchment. (c) Landowners should maintain a **nutrient budget model** for their properties in order to demonstrate compliance with conditions in Rule 3.9.4.11 (Permitted Activity Rule – Fertiliser Application). (j) operators are encouraged to keep good fertiliser application records including (viii) the **nutrient budget** for fertiliser applied onto areas where biosolids or effluents are also applied as a fertilised substitute.

[22] Non-point Sources include runoff and/or subsurface flow from agricultural land.

Regulations/ Standard/ Guidance	Implementation body	Comment
		3.10 – Lake Taupo Catchment **3.10.5 – Implementation Methods – Land use and Discharge Controls** 3.10.5.2 – Permitted Activity Rule – Nitrogen Leaching Non-Farming Activities a) where the use of land is used for planted production forestry (iv) a nutrient analysis of foliage must be used to plan fertiliser application and must be made available to Waikato Regional Council upon request. 3.10.5.12 Nitrogen Leaching Rate For the purposes of determining nitrogen leaching amounts under Rules 3.10.5.1 to 3.10.5.9 the following **nitrogen leaching** rates shall be applied where relevant: (a) Use of land described under Rule 3.10.5.1 has a leaching rate of 8 kilograms per hectare per year. (b) Use of land described under Rule 3.10.5.2 has the following leaching rates: i) Unimproved land (including gorse and broom scrubland) **2 kilograms of nitrogen** per hectare per year; ii) Non-nitrogen fixing plantation forest land **3 kilograms of nitrogen** per hectare per year c) Use of land for farming activities except under Rule 3.10.5.1, that may result in nitrogen leaching from the land and entering water, has a nitrogen leaching rate of an amount calculated using Version 5.4.3 of the **OVERSEERTM nutrient budgeting model** d) An advanced wastewater system in accordance with Rule 3.10.6.3 has a leaching rate of **3.5 kilograms of nitrogen** per year. e) A conventional wastewater system in accordance with Rule 3.10.6.4 has a leaching rate of **10.0 kilograms of nitrogen** per year. (c) Use of land for farming activities except under Rule 3.10.5.1, that may result in nitrogen leaching from the land and entering water, has a nitrogen leaching rate of an amount calculated using Version 5.4.3 of the OVERSEERTM nutrient budgeting model. (d) An advanced wastewater system in accordance with Rule 3.10.6.3 has a leaching rate of 3.5 kilograms of nitrogen per year. (e) A conventional wastewater system in accordance with Rule 3.10.6.4 has a leaching rate of 10.0 kilograms of nitrogen per year. Chapter 5 – Land and Soil Module **5.2 Discharge onto or into Land**

Regulations/ Standard/ Guidance	Implementation body	Comment
		Explanation and Principal Reasons for Adopting Methods 5.2.8.1 to 5.2.8.4. The composting of green waste is an activity that Waikato Regional Council wishes to encourage in accordance with Policy 1 of this Chapter (low risk discharges onto or into land under). Significant quantities of green waste are produced in the Region each year. Much of this waste is disposed of in landfills or dumps where its decomposition contributes to the generation of landfill gases and leachate. However, green waste represents a potential resource if it is composted and recycled as a soil conditioner. 5.2.8 Implementation Methods – Composting of Green Waste and Other Organic Materials 5.2.8.1 – Permitted Activity Rule – Small Scale Composting (a) Volume of compost produced restricted to 20 m^3 per year. (b) The material to be composted shall not contain any hazardous substances or biosolids. (c) Leachate produced during the process of composting shall not be discharged into any water body. (d) Discharge of air from the activity must comply with conditions in section 6.1.8. (e) If the discharge is within the Lake Taupo catchment the compost shall be sourced within the property it is discharged to. 5.2.8.2 – Permitted Activity – Green Waste Composting (a) maximum volume of green waste and compost being stored, processed or cured on site at any one time is 15,00 m^3. With a maximum of 500 m^3 actively composting at one time, maximum of 100 m^3 waiting processing at one time unless mixed with coarse or woody material (ensuring aerobic composting) in this case 500 m^3 can be stored. (b) Where composting is an existing activity, the site shall be located 250 m or more away from buildings occupied by people on a regular basis. (c) Where composting is a new activity, the site shall be located 500 m or more away from buildings occupied by people on a regular basis. (d) Discharge of air from the activity must comply with conditions in section 6.1.8. (e) Leachate produced during the process of composting shall not be discharged into water unless separately authorised by a resource consent. (f) Any material with a known potential to cause objectionable odours must be covered before the end of the working day.

Regulations/ Standard/ Guidance	Implementation body	Comment
		5.2.8.3 – Controlled Activity Rule – Existing and Large-Scale Green Waste Composting (a) Leachate produced during the process of composting shall not be discharged into any water body unless separately authorised by a resource consent. (b) The material to be composted must not contain or be derived from hazardous wastes or pathogenic wastes. Waikato Regional Council reserves control over the following: i. Controlling air quality from objectionable odour or objectionable particulate matter. ii. Measures for stormwater control and leachate management. iii. Controlling source and quality of material being composted. iv. Effects on any waahi tapu or other taonga from the activity. v. Effects on the relationship of tangata whenua and their culture and traditions with the site and any waahi tapu or other taonga affected by the activity. vi. Effects on the ability of tangata whenua to exercise their kaitiaki role in respect of any waahi tapu or other taonga affected by the activity. vii. Any contingency measures necessary to avoid, remedy or mitigate adverse effects associated with the failure to successfully dispose and / or sell composted product. viii. Any measures necessary to rehabilitate the land following the completion of the activity. ix. The need for buffer zones or other measures to avoid or mitigate the effects of discharges to air. 5.2.8.4 – Discretionary Activity Rule – Other Composting Operations Any discharge of contaminants onto or into land, water or air associated with the composting of organic waste that does not comply with Rules 5.2.8.1, 5.2.8.2 or 5.2.8.3 is a discretionary activity (requiring resource consent). *There are related rules under Chapter 7 – Geothermal Module. Rule 7.6.6.2 'Permitted Activity Rule – New activities in the vicinity of Significant Geothermal Features' and Rule 7.6.6.3 'Discretionary Activity Rule – Activities in the vicinity of significant geothermal features. The rules stipulate that there shall not be any direct deposition of a contaminant, clean fill, solid waste, soil, sediment or vegetation beyond two meters and ten metres respectively of the activity or any structure.*
Waikato Prioritisation Framework and its use for soil conservation -	Local Government	The purpose of the Waikato Prioritisation Framework (WPF) for soil conservation is to provide a consistent approach for the planning and implementation of the mitigations for soil conservation across the Waikato region.

Regulations/ Standard/ Guidance	Implementation body	Comment
development and methods (Waikato Regional Council, 2021)		The Waikato region comprises eight management zones which are managed independently. The use of management zones recognises the variation in geology, topography and soil conservation-related issues across the region. The eight management zones are delineated into 354 sub-catchments. The WPF informs soil conservation works at a sub-catchment scale by identifying locations of highest risk and greatest potential opportunity for focusing and prioritising work programmes for soil conservation and their water quality improvements. The WPF combines multiple sourced spatial model data and applies geospatial analysis techniques to derive prioritisation rankings (scores) for managing soil conservation, at multiple scales, across the Waikato region. The WPF can be used to inform soil conservation works at a sub-catchment scale by identifying locations of highest risk and greatest potential opportunity for focusing and prioritising soil conservation work programme. Factors can be grouped to represent key issues. Three key issues have been developed for the WPF, of which two (soil conservation and water quality) are currently being used. The third issue (biodiversity) is under revision. Available research literature has been used to develop estimates of the likely sediment, nitrogen, phosphorus, and faecal microbe reductions achieved when implementing mitigations. WPF outputs have been used in numerous soil conservation projects at Waikato Regional Council since 2013/14 and provided data to support various funding applications for soil conservation. The document is primarily used by Waikato Regional Council, although it has benefits to iwi partners, the Waikato River Authority (WRA), co-governance partners and land managers, funding agencies and communities within the wider Waikato region.
Waikato Regional Waste Infrastructure Stocktake and Strategic Assessment (Waikato Regional Council, 2007)	Local Government	• A stocktake has since been produced in 2021, but has yet to be released. • A stocktake of waste and recovered material flows and facilities in the Waikato Region. • The objective of the project was to provide a comprehensive picture of waste management in the region with a view of identifying gaps and opportunities for improvements as contracts expire and infrastructure requires renewals. Noting that this document was written in 2007, therefore the current picture for Waikato Region may have developed. • Section 6.1 'waste in the Waikato Region' details the big picture for waste in the Waikato stating major components of the waste stream going to landfill are organic waste (garden waste, food processing waste, wood processing waste – 175,000 tonnes per year). • Section 6.2.1 'overview of recoverable materials' details putrescible wastes (green waste, food waste and primary processing wastes) and wood wastes (silvers, recovered fibre and treatment sludge) as waste streams which are significant and potentially recoverable waste stream from the Waikato region. The report notes potential diversion opportunities for organic materials as compost, drying, and anaerobic digestion domestic collection.

Regulations/ Standard/ Guidance	Implementation body	Comment
		• Section 6.2.2 and 6.2.3 discuss the recovery of green waste and other organic wastes respectively. – During the period of this report a significant amount of green waste was diverted in the Waikato region with the report suggesting there is further opportunity for diversion. A trend was noted of increased composting of putrescible waste which means there is a need for bulking agents such as green waste or bark which will increase the value of these waste streams in the future. – In relation to food waste the report notes there are several options for processing and beneficial use however, decisions need to be made at company or council level. Opportunities are noted for undertaking an options study or collaboration between local authorities and private sector waste generators. – Wood processing during the period of this study was predominantly sent to landfill where it was unsuitable for boiler fuel. The document notes the potential for construction and demolition waste timber to be used for additional compost and soil conditioner manufacture, energy recovery and mixing with feedstock for chemical or other product manufacturing. • Overall suggestions from the report are to undertake a regional options study for multiple waste streams including green waste and other organic wastes. Within the food waste stream, the report details the most appropriate processing options for the waste stream in Waikato is composting, anaerobic digestion and vermicomposting. An updated Waste and Recycling Stocktake has been undertaken in 2021 covering the Waikato and Bay of Plenty Regions. This document is yet to be released by the Regional Councils.
Waikato River Documentation		
A tool for freshwater nutrient management in the Waikato-Waipa catchment (Waikato River Authority, April 2015)	Local Government *Mandatory*	Document written by a joint venture between; Waikato River Authority23, Waikato Regional Council, DairyNZ, Ministry for the Environment and Ministry for Primary Industries. There is no reference to the processing or organic material into a compost product. However, this resource details the contaminants leaching into the Waikato-Waipa catchment in which organic material processing (compost) could have an impact. Nitrogen is referenced as a contaminant which impacts on water quality being derived from several sources including waste.

[23] Waikato River Authority – The WRA was established in 2010 by the Guardians Establishment Committee. The purpose of the authority is to restore and protect the health and wellbeing of the Waikato River. With an organic waste lens, the authority has an interest in how waste affects the water quality. There is a focus on processes within the Waikato can be improved to address water quality issues with a holistic view protecting the health and wellbeing of the Waikato River for future generations.

Regulations/ Standard/ Guidance	Implementation body	Comment
		Grazing animals urinating on pastures deposit concentrated nitrogen on to soil, and where this is not taken up by plants, it may leach through the soil. Human sewage is also rich in nitrogen compounds, as can be wastewater from some industrial processes.
Restoring and protecting health and wellbeing of the Waikato River (Waikato River Authority, 2019)	Local Government	Sets out the vision and strategy for the Waikato River. There are 13 clearly set objectives and 12 strategies for achieving the objectives. In relation to organic waste processing objectives (h) and (k) reference the degradation of the Waikato River by human activity and the restoration of water quality efforts which are required to ensure the river is safe for swimming and to take food from over its entire length.
Waikato River Independent Scoping Study *Appendix 13: Water Quality* (Waikato River Authority, 2014)	Local Government	The purpose of the Waikato River Independent Scoping Study is to identify priority actions and associated costs of those actions necessary to rehabilitate the health and wellbeing of the Waikato River and its tributaries, wetlands and lakes for future generations. Appendix 13 of the document focuses on water quality. This appendix evaluates the Waikato River's water quality, specifically the nutrients nitrogen (N) and phosphorus (P), phytoplankton (measured as chlorophyll a), clarity and colour under existing and possible future management options. The principal sources of phosphorus in the Waipa River are farm run-off, soil erosion and treated sewage. The principal source of nitrogen is leaching of nitrate in farmland. Land disposal of municipal effluent is listed as one of the priority actions in Section 8 in the main report. There is also a focus on potentially moving to chemical or biological treatment to further reduce nutrient loads (particularly for sewage disposal) on the land which may be most cost-effective than wetland or land disposal.
Compost / product standards		
New Zealand Standard 4454 – Compost, soil conditioners and mulches (December 2005)	Procedure *Voluntary*	Requirements within the standard are spilt across seven general requirements which investigate the following: • Containment of pathogens and propagules • Product classification • Process criteria • Sampling of material • Microbiological sampling • Product testing • Product analysis • There is also additional requirement around packaging, marking and documentation. Within the general requirements the following are detailed:

Regulations/ Standard/ Guidance	Implementation body	Comment
		• Limits for heavy metal contaminants and organic contaminant residues have been included in alignment with the interim values of the Biosolids Guidelines issued by the New Zealand Water and Wastes Association, 2003. • Limits for indicator organisms, have been included to ensure microbiological quality of certain categories of products. • The standard does not place limit on acceptable levels of amine herbicides in compost. Composting process best practices are covered in Appendix K which cover the following methods; turned pile, aerated static pile (ASP), windrow and invessel or enclosed configuration.
BioGro (organic product certifier) Technical Guide – Compost Guideline	Procedure / Standard *Voluntary*	BioGro is not a mandated certification for growers under a New Zealand framework. However, there could be contractual or supply chain requirements for producers to have a certified organic process. There is also a greater pull for producers to ensure the sustainable upkeep of their land for future security. There are 11 standards for specific organic sectors. • Guideline for BioGro certified primary producers making aerobic compost, anaerobic compost or vermicompost for use on their certified properties. • High nitrogen levels are deemed a high-risk product. • Ingredients – Preference for the producers to only use ingredients sourced from own / other certified properties in compost production. Where ingredients are not used from certified properties supporting documents will be required to assess the ingredients. • Compost process – Three composting processes (hot compost, raw compost and vermicompost) are detailed with specific requirements to ensure the process produces an acceptable product. • Approval and testing requirements – Stipulating the requirements for the compost to meet (colour, smell, moisture content etc) prior to use. • Can be used as a simple guide for smaller composting works to follow. BioGro certify an organic product type using organic processes and principles – they do not certify organic compost as a standalone item.
BioGro – Module 1 Introduction	Procedure / Standard *Voluntary*	• The New Zealand Biological Producers and Consumers Council Inc (NZBPCC) was founded in 1983 to promote the interests of organic production in New Zealand. NZBPCC maintain and develop the BioGro standards. • Consumer input to the Standards is obtained through key organic sector organisations. • Main certifier for New Zealand's exports of organic products the BioGro Standards must meet or exceed all regulatory requirements of overseas markets. Module 1 sets the principles for organic production and the use of the BioGro Organic Standards.

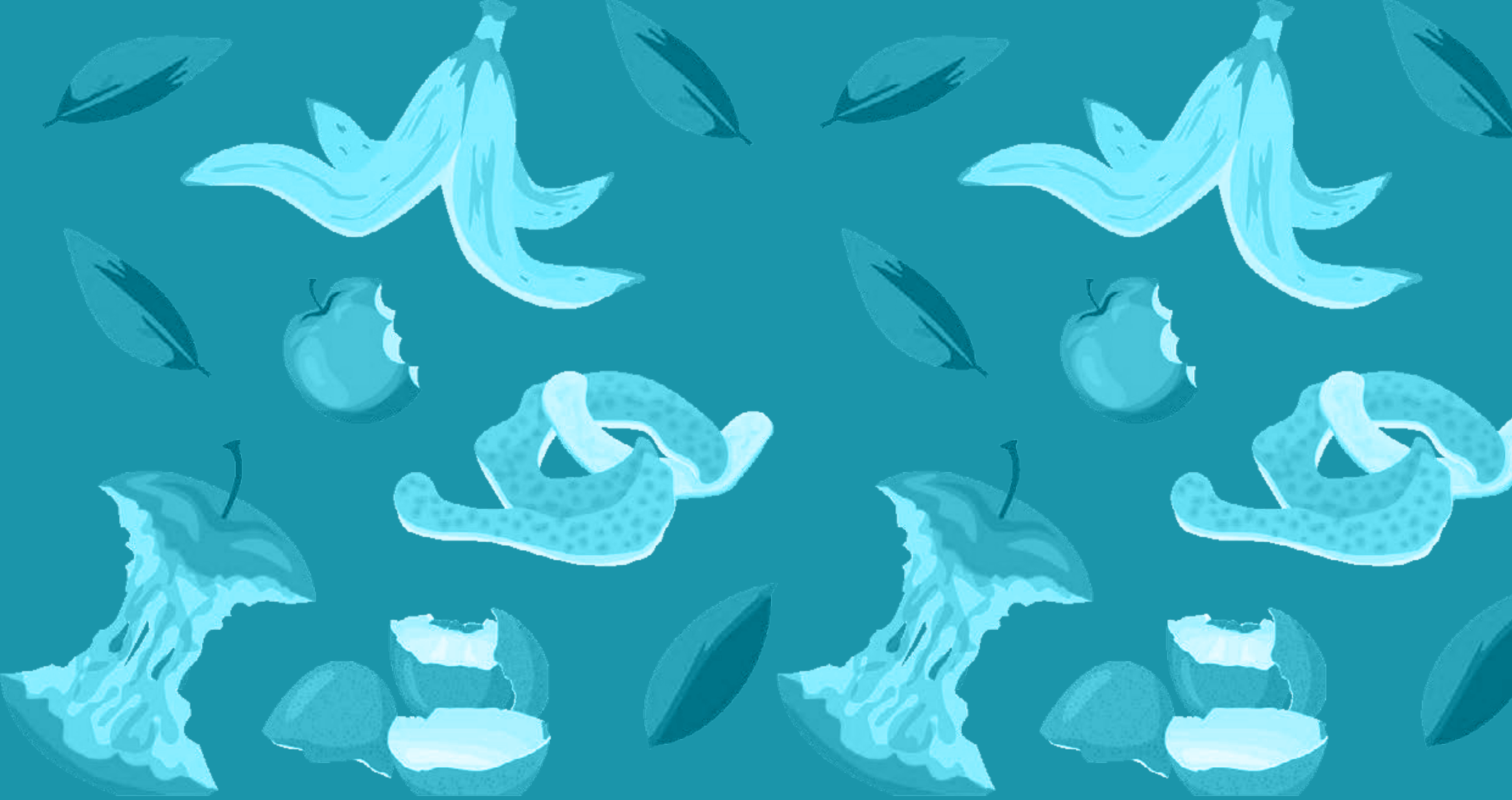
Regulations/ Standard/ Guidance	Implementation body	Comment
BioGro – Module 3 certification system	Procedure / Standard *Voluntary*	This standard contains the systems and audit requirements for the certification and licensing by BioGro of users of the BioGro trademarks and logos. This standard supports the modules for specific industries e.g. Module 4 Orchard Production.
BioGro – Module 22 standard for evaluation of inputs	Procedure / Standard *Voluntary*	This BioGro Standard contains the requirements for BioGro certification of input products for use in BioGro certified organic production systems.
BioGro – Module 4 Orchard Production Standard	Procedure / Standard *Voluntary*	This BioGro Standard contains the production requirements and audit criteria for the certification and licensing by BioGro of producers of organic perennial orchard crops, bush, vine and tree crops, and berries (excluding strawberries) to use the BioGro trademarks and logos. Within the standard there are six principles to be followed including; soil and fertility, water supply and irrigation, tree/vine/bus establishment and management, sward, pest and disease management and finally harvesting, packing, storage and transport. The guiding principle for soil and fertility organic orchard production system must aim to sustain and enhance the fertility and life-supporting ability of the soil, including its biological, physical and chemical components. Emphasis is on the importance of soil organic matter, soil flora and fauna, achieving cycles and flows of nutrients and organic matter which will conserve and enhance soil fertility and humus. The standard requires the following in relation to soil and fertiliser: • Compost and living mulches are promoted for soil organic matter. • The standard stresses the importance of compost being carefully managed whilst in use to ensure the use does not lead to pollution of soil or water by leaching. • Soil testing is required annually to monitor fertility levels to ensure the soil is maintained and enhanced, determining whether mineral supplementation is necessary and appropriate and determine the need for restricted fertilisers use. • Compost made on the orchard must be: – made from ingredients sources from certified properties and ingredients in compliance with the *BioGro Compost Guide*. – Heated, aerated and mixed, matured sufficiently and have been produced in compliance with the requirements of the *BioGro Compost Guide*. • Vermicasts made from low risk ingredients approved by BioGro do not have to go through a heat process • Management of composts must comply at all times with the requirements of the local authority.

Regulations/ Standard/ Guidance	Implementation body	Comment
		• Application rates of compost along with other fertiliser additions must not lead to excessive levels of available nitrogen applied through the use of approved composts and foliar fertilisers should be no more than that required for the current crop, and a guide should not exceed 170 kg nitrogen per hectare per year. With the exception of certified property's own diary or pig effluent from the certified area and certified livestock, raw animal manures must not be applied directly to soils. Raw animal manure must be hot composted before use.
BioGro – Module 5 Livestock Production Standard	Procedure / Standard *Voluntary*	This BioGro Standard contains the production requirements and audit criteria for the certification and licensing by BioGro of producers of organic livestock and livestock products to use the BioGro trademarks and logos. Livestock includes cattle, sheep, dairy animals, goats, pigs, poultry, ratites, deer and horses. Within the standard there are nine principles to be followed including: • General – quarantine area • Soil and fertility • Water supply and irrigation • Pasture and feeding • Breeds, breeding and incoming stock • Housing and management • Livestock health, welfare and treatment • Transport and slaughter • Livestock products The requirements under 'soil and fertiliser' as the same as stipulated in 'Module 4 Orchard Production Standard'.
BioGro – Module 9 Crop Production Standard		This BioGro Standard contains the production requirements and audit criteria for the certification and licensing by BioGro of producers of fresh and process vegetables, arable and seed crops, herbs, flowers and annual fruit crops e.g. strawberries to use the BioGro trademark and logos. Within the standard there are seven principles to be followed including: • Soil and fertility • Water supply and irrigation • Seeds, varieties, transplants and crop management • Weed management • Pest and disease management • Harvesting, packaging, storage and transport • Container growing systems

Regulations/ Standard/ Guidance	Implementation body	Comment
		The requirements under 'soil and fertiliser' follow the same principles as stipulated in 'Module 4 Orchard Production Standard' however there are further requirements in relation to certified organic seeds, seedlings and vegetative propagation materials, genetic engineering is prohibited.
Asure Quality – Organic Standard (June 2020)	Procedure *Voluntary*	The Standard sets out the principles of organic production at farm, preparation, storage, transport, labelling and marketing stages, and provides an indication of accepted permitted inputs for soil fertilising and conditioning, plant pest and disease control, food additives and processing aids. The requirements of the standard cover eight key areas which include: • Labelling and claims • Crop and pasture management • Livestock • Processing and handling • Imported product and/or ingredient • Grower groups • Retail and wholesale • Restricted permitted substances for the production of organic foods. Within Section 1.9 'Overview of Standard' the requirements which are applicable to each applicant / organisation are stipulated in a table. Under the standard an annual audit is required to maintain certification status. The Crops and Pasture Management section of the Standard include sub-sections titled 'soil and soil management' and 'soil and water conservation'. The subsection on soil management promotes composting to take the form of either aerobic or anaerobic techniques and is recommended within the organic production system as an effective means of cycling and binding nutrients, while eliminating or reducing hazardous agents such as potentially lethal microbes and weed seeds. The NZ Standard for composts, soil conditioners and mulches (4454:2005) is referenced for minimum composting periods for each technique. Feedstock for compost shall ideally be from certified organic sources and / or on-farm sources. If an off-farm source is sought this requires verification by the operator to be free of levels of contaminants which may pose a longer-term contamination risk to the farming operation and the production of clean food. The emphasis of clean feedstock to prevent food safety risks arising from editable crops is clear through the requirements of these sub-sections. Subsection for soil and water conservation focuses on sustainable practices to maintain or improve the landscape and enhance biodiversity quality for the site. The standard states in multiple clauses where additional nutrients/pesticides are required to be added to produce/livestock these must be in compliance with the requirements of Table 1 in Section 10.

Regulations/ Standard/ Guidance	Implementation body	Comment
Global Gap – Sustainable Agriculture	Client / Procedure *Voluntary*	The IFA standard includes three scopes containing multiple product categories that cover agriculture, floriculture, aquaculture, and livestock. The certification status of all producers is visible in the GLOBALG.A.P. IT systems for transparency in the supply chain. The IFSA standard is made up of several documents including (a) the rules which map out the requirements for successful implementation of the standard (b) the checklists which include principles and criteria clearly defining the requirements (c) national interpretation guidelines which clarify how the principles and criteria have been adapted in specific countries and (d) standard guidelines available for each product category. There are two IFA editions (1) GFS and (2) SMART. The two editions are available in parallel and are equally valid. The SMART editions are the flagship editions and the GFS version has been adapted to meet the GFSI (Global Food Safety Initiative) requirements. Examples of components of the Global G.A.P. system are Integrated Farm Assurance GFS 25 and Integrated Farm Assurance Smart 25. These documents are the checklists for fruit and vegetable producers stipulating the principles and criteria for the requirements. Sections FV-GFS 25 and FV-SMART 25 of respective checklists cover identical requirements for 'waste management'.
Integrated Farm Assurance GFS – Principles and Criteria for Fruit and Vegetables	Client / Procedure *Voluntary*	These include the following recommendations: Organic waste should be composted and used for soil conditioning with the methods ensuring no risk of pest, disease or weed carryover. Food waste should be redirected into recycling, compost or land application where it is not used for human consumption, animal feed or bio-based materials. Sections FV-GFS 28 and FV-SMART 28 of respective checklists cover identical requirements for 'soil and substrate management'. These include: Soil management and conservation – which requires analysis of soil profiles to ensure the nutritional needs of the crops and soil is maintained, Soil fumigation – which requires documented evidence and justification for the use of soil fumigants and the restriction of the use of methyl bromide as a soil fumigant. Substrates – which requires records to be maintained of chemicals used to steriliser substrates for reuse and these chemicals are to be from natural origin.
Integrated Farm Assurance Smart – Principles and Criteria for Fruit and Vegetables		
Integrated Farm Assurance Smart – Principles and Criteria for Hops		
Integrated Farm Assurance Smart – Principles and Criteria		

Regulations/ Standard/ Guidance	Implementation body	Comment
for Flowers and Ornamentals		Sections FV-GFS 29 and FV-SMART 29 of respective checklists cover identical requirements for 'fertilisers and biostimulants'. These include the following 'major must' requirements: Records can demonstrate the interval between the use of composted organic fertilisers and harvest does not compromise food safety. The use of human sewage sludge that has been composted or incorporated into a commercially available product is not permitted, regardless of lawful use according to prevailing regulations.



Chapter 3

Localising Organics

The role of home-based, small and medium-scale activities in an organics diversion ecosystem for the Waikato region - learnings from Aotearoa and around the world

Liam Prince
The Rubbish Trip

Raquelle De Vine
Tonkin + Taylor

December 2023

This report provides consideration of how a regionally coordinated approach to collecting and processing organics at the home, neighbourhood, suburb, town, city and regional levels may function side-by-side and complement each other to achieve a range of positive outcomes. It explores the benefits and opportunities for multiple systems to work together.

Contents of Chapter 3

1 Introduction

With organics diversion rising to the top of Aotearoa New Zealand's government policy agenda through the Emissions Reduction Plan, Te Rautaki Para | Waste Strategy, and mandatory organics collections (see Chapter 1 - Introduction, from page 17, for discussion of policy context), local authorities will be looking for cost effective solutions to meet their regulatory requirements. At present, district and city councils will be required to provide residential organics collections to urban areas (i.e. towns of 1000 people or more) by 2030 at the latest, or 2027 for those within 150km of large-scale, regional organics processing facilities. While these requirements signal the necessary changes that will be needed to divert organics from landfill at scale, they provide no detail or guidance on the range of approaches that could form part of an organics diversion ecosystem.

Collecting and processing organics at small and medium-scale local facilities is often seen as a distinct approach to large-scale kerbside collections and processing facilities. At worst, they are seen as competing, 'either/or' approaches. The relative simplicity and prevalence of large-scale, centralised processing and collection systems, which allow for economies of scale and a consistent level of service (Pai et al. 2019, p. 2), has seen them continue to receive the bulk of support and focus from decision makers. For such reasons, local authorities have often disregarded "on-site composting, and more broadly, low-tech or artisanal mechanisms and practices (such as rainwater collectors) as techniques for managing the flows of integrated urban services" (Lehec 2020, p. 94), a tendency exacerbated by the timeframes imposed by central government to implement collections. These pressures favouring large-scale industrial systems could compete with emissions reduction, circular economy and community wellbeing goals. There is comparatively little consideration of how a regionally coordinated approach to collecting and processing organics at the home, neighbourhood, suburb, town, city and regional levels may function side-by-side and complement each other to achieve a range of positive outcomes.

This Chapter attempts to address this gap in system design for organics diversion. Rather than comparing or contrasting 'centralised' with 'decentralised' approaches as an either/or discussion, as many such comparisons do, this Chapter explores the benefits and opportunities for multiple systems to work together. Drawing on international and local case studies, the Chapter aims to move beyond the common assumption that organics diversion at home and smaller scales are primarily non-technical behaviour change or social policy tools that require (and, consequently, receive) little technical support or resourcing for optimisation (Lehec 2020). Instead this Chapter explores how an integrated waste management system can help maximise diversion, participation and product quality, and minimise contamination across the full suite of services.

Section 2, 'Defining 'local' organics management', discusses a variety of terms, practices and models typically associated with terms like 'localised', 'decentralised' or 'community composting'. It employs terms such as 'onsite, small and medium scale' (OSMS), drawn from the waste hierarchy adopted in this report, to articulate their unique characteristics in relation to large-scale kerbside collections and regional processing facilities, notably in emphasising localism.

Section 3, 'Key considerations for an integrated approach to organics diversion', discusses a range of issues that demonstrate the benefit of 'localised' activities working in tandem with large-scale systems, and how a diversity of services can be mutually reinforcing to maximise diversion and achieve a variety of outcomes that cannot be achieved with more limited, standardised services. The section discusses the benefits of having OSMS activities as part of a suite of services in terms of infrastructure (costs and impacts, speed of implementation, and achieving scale), adding value (through markets, behaviour change, community engagement and economic opportunity), mitigating problems, reducing contamination, and boosting participation.

Section 4, 'Supporting and integrating local organics diversion', discusses how particularly local government can support OSMS systems, and support education and outreach for all organics diversion services, through a variety of policy and procurement mechanisms, and outlines a range of basic scenarios for integrated organics diversion ecosystems.

Section 5/Appendix, provides a list of tools and resources on localised systems that have informed this Chapter and provide further information for those who are interested in setting up such systems in their own communities.

2 Defining 'local' organics management

Despite their widespread usage, terms like 'decentralised' organics management and 'community composting' are not simple to define. These terms are frequently used interchangeably in literature, and yet represent a significant diversity of practices, models and meanings - from home composting or onsite management, neighbourhood composting hubs (e.g. at community gardens), medium-scale onsite (e.g. institutional) or on-farm processing systems, and many more. Home composting is broadly understood and needs little explanation. However, organics management systems larger than the home scale tend to fall into simplistic distinctions between terms such as 'community' and 'commercial/industrial' that do not adequately capture the diversity of models and practices.

An emphasis on localism/proximity, or keeping the collection and processing of organic materials as local as possible, brings many of these terms and practices together (Diprose et al. 2023, p. 18). This is evident in numerous definitions from the literature, and from NGOs such as WRAP in the UK ("Organic materials are collected by a group, or delivered by residents and taken to be composted locally" (WRAP 2020, p. 4)), and the US-based Institute for Local Self-Reliance (ILSR), one of the leading community composting advocacy organisations globally, which frequently defines these practices as serving local communities, composting locally, and involving or engaging the community.

In this report, we use the terms outlined in the organics hierarchy (page 23) - 'onsite, small- and medium-scale' (**OSMS**) approaches to organics diversion - to specify activities typically called 'decentralised' or 'community' composting. At times, terms such as 'localised', 'localising' and 'local-scale' are used to emphasise the local-orientation of OSMS activities, which differentiate them from large-scale, regional processing facilities or the widespread kerbside collections that serve those facilities. There may be overlapping and blurred boundaries between such categories, and they should not be read as conclusive definitions of the full range of organics diversion practices, models and systems, but rather as an attempt to identify key distinctions while avoiding common problematic assumptions.

This section begins by defining some key features of home composting, before outlining key definitions and examples of other OSMS practices.

2.1 Home composting

As its name implies, home (or backyard) composting (or vermicomposting, anaerobic digestion etc.) involves the self-managed processing of organic materials at home, by a resident, who also typically uses the finished product (e.g. compost) on-site. Home composting typically only manages materials generated on-site at the home, distinguishing it from ‘home-based’ or ‘homesteader hubs’ that may receive material from multiple sources (see Platt et al. 2014, p. 27).[24]

Because of the small quantities of materials involved, home composting involves the gradual and continuous addition of feedstock, which differs from most other organics processing systems (including onsite processing at a business or institution). This creates a “heterogenous and variable environment for microbes…” involving “different composting processes like aerobic digestion, nitrification and denitrification, which may occur simultaneously” (Mensah 2017, p. 27). Home composting is thus widely variable and difficult to standardise in terms of processes, parameters, feedstocks, emissions and the quality of outputs.

A Ministry for the Environment (MfE)-commissioned survey of home composting in Aotearoa New Zealand (UMR 2021) reported that 55% of respondents compost at home (this is down from 63% from a previous survey in 2008). The survey also revealed a range of common features with home composting in NZ. This included:

- The most common composting systems are “daleks”, open piles, composting bays, and multi-layer manufactured plastic bins. Worm farms and bokashi are also used but are less common (p. 11). Over half use only one bay or bin, and 13% have more than two.
- Piles were mostly slightly warm or not at all, with some very hot (17%). This indicates that home composting typically occurs in mesophilic temperatures (roughly 20-45 degrees), though some may achieve thermophilic temperatures (>45) that typically occur in larger composting facilities.
- Materials composted are limited: most only process fruit and vegetable scraps. 35% also compost cooked food & leftovers, and 11% process meat & dairy.
- Most who already compost have a large garden or farm (p. 12), and the most common reason people don’t compost is because of insufficient garden space (p. 14).
- Home composting is more likely to be done by:
    - Males (59%)
    - Respondents outside of Auckland, Wellington, Canterbury (60%)
    - Home owners without a mortgage (62%)
    - Middle household income ($50-100K) (63%)
    - Those with large gardens, farms or lifestyle blocks (74%) (p. 13).
- Two most common motivations: to reduce waste and get compost for their garden. (p. 22)

Home composting is an age-old practice, but can be a legitimate strategy to bolster diversion of organics from landfill with support and incentives from local government. Many City and District Councils around NZ provide resources/guides, free workshops and sometimes subsidies for equipment (see Appendix). Some local government bodies in other countries have substantial support programmes for home composting (see e.g. ILSR’s report, *Yes! In My Backyard: A Home Composting Guide for Local Government* (Platt & Fagundes 2018) in Appendix B, page 140). These programmes can help improve outcomes and uptake of home composting, and may complement other services like kerbside collections, which will be covered in the following sections of this report.

[24] Peer-to-peer platforms like ShareWaste NZ enables home composters to become home-based hubs

2.2 Onsite, small and medium-scale (OSMS) clubs and service providers

Localised organics management beyond the home consists of a diversity of practices, scales and business models. These are frequently described as 'community composting' or 'decentralised' organics management. A common image of 'community composting' may be a small-scale, volunteer-run operation located at a community facility such as a community garden, where composting "is generally carried out in open composting bays" or in "small-scale In-Vessel Composting (IVC) units… where food waste is included" (WRAP 2020, p. 4). However, the ILSR has categorised community composting programs into 10 types, "generally based either on the type of venue (such as school or farm) or the type of operation (such as collector or composter)" (Platt et al. 2014, p. 24).[25] This multiplicity is reinforced in the ILSR's 2022 census of community composters, which states:

> **"Community composters are diverse. They include farms, demonstration sites, community gardens, on-site composters (composting is done where the material is generated), schools, and home-based hubs. They are nonprofit and for-profit enterprises. Composting systems utilized vary considerably and the amounts of food scraps handled also vary. Operations were as small as home-based hubs using backyard bins and as large as facilities handling over 25 tons per week" (Libertelli et al. 2023).**

Some jurisdictions have created specific legislation to define and provide for 'community composting'. These emphasise the size/scale and, again, proximity. For example:

> **"...in Italian legislation, the definition of community composting is a facility which has a processing capacity of no more than 130 tonnes per annum (TPA), and is located within one kilometre of contributing users (ReteAmbiente, 2023). In California, the Department of Resources, Recovery and Recycling (2020, p. 54) defines 'community composting' as a facility in which "the total amount of feedstock and compost on-site at any one time does not exceed 100 cubic yards and 750 square feet" (Diprose et al. 2023, p. 18).**

The primary purpose of legally defining community composting in this way is to provide exemptions in relation to a wider set of legal requirements for organics management infrastructure. This is covered further in Section 4.

Terms like 'decentralised' or 'community composting' have been criticised for their lack of clarity and abandoned in favour of different terminology. A Zero Waste Network and Manaaki Whenua - Landcare Research report on organics management models in Aotearoa NZ discusses the assumptions and drawbacks of common terminology - in particular, how they reinforce unhelpful and unrepresentative dichotomies between things like community and commercial activities, and create a sense of incompatibility between centralised and decentralised approaches (Diprose et al. 2023, pp. 16-20). Instead, the report proposes a new way of distinguishing different composting initiatives or enterprises in two ways; first, by whether they are either 'composting clubs' or 'composting service providers':

> **"In essence, a composting service provider charges a pay-for-service fee and processes materials that are mostly (if not wholly) generated off-site. In contrast, composting clubs**

[25] These 10 types are: community gardens, farms, schools, drop-off networks, collection entrepreneurs, on-site composters, off-site composters, demonstration and community leader training sites, worker-owned cooperatives, and home-based or homesteader hubs.

are projects serviced wholly or primarily by volunteers and/or which exist as an internally-funded on-site solution to a particular organisation's organic materials (such as hospitals, schools, or a business managing their business waste on-site)" (p. 20).

Second, Diprose et al. (2023) categorise composting service providers into four model types, distinguished by whether they use a single processing site or multiple sites across a distributed network, and by whether they serve a small or large geographic area, with examples of each type (see Figure 1).

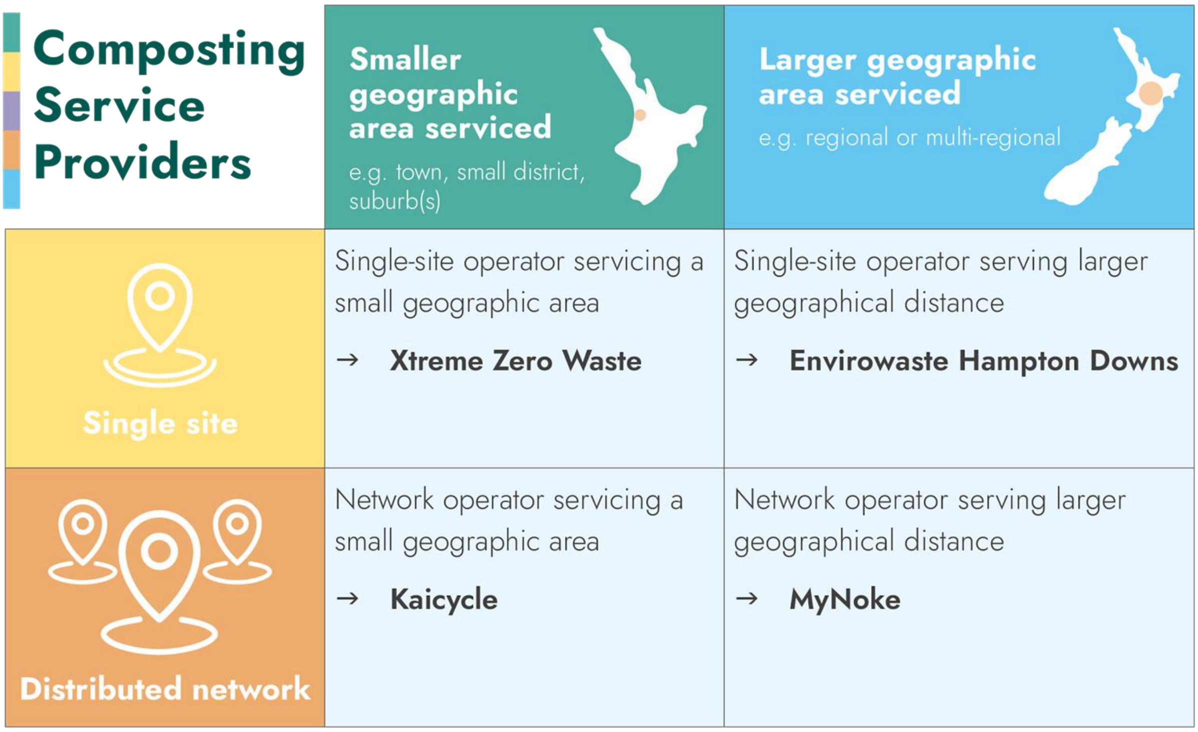


Figure 1 from Diprose et al. 2023, p. 17

Grouping models into either non-procurable 'clubs' or procurable 'service providers' in this framework/taxonomy blurs common distinctions between 'centralised' and 'decentralised' or 'community' and 'commercial' models. This helps bypass the perception that typically treats conventional 'community vs commercial' models as incompatible with each other or as separate systems. The framework/taxonomy can also shift the focus for councils and communities towards developing integrated organics management services by guiding how best to engage with different models of service delivery, determining what their strengths and weaknesses are relative to other models (see Section 3), and the types of support required. This framework is incorporated into the options for integrating organics services in Section 4.

2.3 Organics management types according to waste hierarchy

The Circularising Organics waste hierarchy on page 23 sets out a preferential order for preventing, reducing, managing and ultimately disposing of food and other organic materials. In the middle of the hierarchy (organics recycling/management), the preferential order starts with **onsite organics processing/management**, followed by **small-scale locally-based** management, then **medium-scale locally-based** management, and finally **large-scale regional** management.

This section describes some of the types of activities that might fall into **small-scale locally-based** and **medium-scale locally-based** management. We do not provide a separate discussion of **onsite** organics management (apart from home composting - see description above); the methods, locations and technologies used in **onsite** activities directly overlap with small and medium (and sometimes even large) scale activities (depending on the nature, size, purpose, location etc. of the activity), with the key difference being materials processed are wholly (or in large part) generated onsite. End products are also typically used onsite.[26] See the definition as part of the organics hierarchy on page 23 of this report.

2.3.1 Small-scale, locally-based

Small-scale organics management and small-scale collection services.

This could include neighbourhood scale compost clubs or services processing roughly <1-10 tonnes per site per annum. Small-scale may enable bicycle pick up or allow community members to drop off, such as at Kaicycle in Wellington (p. 23).

These initiatives typically involve low-tech equipment (e.g. compost boxes, bays, open piles/windrows, worm farms) that are manually operated, and may be managed by a mix of (or wholly) paid staff and/or volunteers. They occur at sites such as community gardens, schools, marae, parks, multi-unit dwellings (MUDs) with adequate space, or at home-based hubs - sites where composting is usually not the primary activity/purpose. Organic materials may be sourced entirely from on-site (e.g. schools/marae/MUDs) or off-site via local collections (e.g. on bicycles) or from drop-off sites. These initiatives often act as demonstration sites for composting training and workshops.

Such initiatives, if operating as standalone sites, would likely be considered 'composting clubs' - primarily volunteer-run or in-house solutions that do not provide a service to the wider public. However, enterprises could be procured by local government to provide support, management, and/or mentorship services for a coordinated, distributed network of sites (e.g. multiple schools, neighbourhoods or housing developments) within a dedicated area.

Examples in Waikato:

- The Fairfield Project (Hamilton)
- Western Community Centre (Hamilton)
- Moanataiari School (Thames)
- Enrich+ (Te Awamutu)
- Marae
- Why Waste (Service provider offering an **onsite** solution across the country)

Case Study - Besançon
In the city of Besançon, France, the cooperative company, Trivial Compost, is contracted by local government waste management entity (SYBERT) to establish small-scale composting sites at

[26] Onsite organics management is defined in this report as:
"Processing organics at the location of their generation and the onsite use of composted material.
The on site processing of organics and on site use of the resulting material reduces transport costs/energy and connects users to the system in use. This could include composting, vermi-composting or small scale anaerobic digestion at locations such as the home, business or Marae. On farm processing of material generated on the farm would also be considered "on site". The tonnes per annum could vary considerably with on site processing and could be small or large" (p. 23).

apartment blocks, businesses and schools. Trivial Compost offers comprehensive, ongoing support and training to residents (or business/school employees) to establish and manage onsite composting, with equipment, materials and running costs subsidised/supplied by SYBERT. Since 2012, Trivial Compost and SYBERT have established over 300 apartment-based composting sites across the city and surrounding areas. They also offer other types of organics collection and processing services, including support for home composting and agricultural waste composting. All EU Member States are required to separately collect organic materials (‘biowaste) by 1 January 2024. SYBERT intends to meet this obligation through enhancing its current approach and expanding its offerings, prioritising local composting (SYBERT 2022, pp. 18-20).

2.3.2 Medium-scale, locally-based

Town or farm scale composting designed to serve a defined geographic area.

For example, systems that handle roughly up to 500 tonnes of material per annum. Xtreme Zero Waste in Raglan services the Whāingaroa geographic area and processes roughly 300 tonnes per annum. Could be a single site or a network of sites that process a similar quantum of material (p. 23 of this report).

Medium-scale locally-based initiatives provide organics collection and/or processing services for a relatively small area (e.g. an area of a city or a small town). Processing facilities may be located at sites such as public parks (or other underutilised public land/facilities), farms, resource recovery centres, and commercial premises, and may be operated as a single-site model, or as part of a distributed network of other small and medium-scale initiatives. They typically involve the use of some small-scale mechanised equipment (e.g. tractors, diggers, skid steers, feeders, in-vessel composting units, sifters/screeners, shredders).
Examples in Waikato:

- Xtreme Zero Waste
- Little Buddies

3 Key considerations for an integrated approach to organics diversion

Much has been said and written about the standalone benefits and opportunities of local-scale, community-based organics management (see e.g. the work of the Institute for Local Self-Reliance (ILSR)). These include social (community cohesion and behaviour change), environmental (soil health, and contamination and emissions reduction), economic (local food security/resilience), and cultural (learning/teaching ancestral traditions, reconnecting to nature) outcomes.

Such benefits, while useful to highlight the potential advantages of localising organics management, are sometimes emphasised to position some approaches as preferable to others, rather than identifying the potential for integration and how their various benefits, drawbacks, challenges and opportunities may complement one another.

The unique strengths, costs and challenges of different approaches are important and relevant to consider for any type of organics diversion system. In some circumstances (e.g. areas with lower population density), small and medium scale infrastructure may support the best overall outcomes for organics diversion, including when cost efficiencies, logistics, and other conventional measures are accounted for, while in other circumstances, large-scale infrastructure may be most effective way of achieving the necessary economies of scale.

Other reasons may place OSMS activities in conflict with large-scale collections and processing infrastructure. For example, some very large processing facilities may require contractual guarantees of minimum quantities of organic material to be provided to remain viable, which can disincentivise local authorities from providing support for OSMS approaches for fear of material being diverted from kerbside collections. However, as this section discusses, not only are OSMS suited and likely to support diversion in addition to (rather than instead of) large-scale systems in many cases, they can also support and enhance participation in all types of services (see 'Participation' at the end of this section), and support rather than hinder local authorities in meeting their contractual obligations to service providers. In addition, authorities should also be wary of the potential for contractual obligations for minimum quantities to delay and derail waste prevention and reduction activities at the top of the waste hierarchy.

This section adds to discussion of the waste hierarchy on page 23 of this report. In particular, it expands on the reasons behind the arrangement of the middle tiers of the waste hierarchy, highlighting key strengths, weaknesses and other considerations of onsite, small, medium and large scale approaches to organics diversion, and how they may interact and complement each other. It is not a comprehensive list of considerations, but focuses on a range of key issues relevant to an integrated approach to organics diversion. This section also discusses the effect these considerations may have on contamination and the quality of inputs and outputs (see Chapter 4 for a literature review on contamination mitigation), and concludes by discussing the issue of participation in organics management systems, focusing on how local approaches may help increase participation and therefore overall diversion.

3.1 Key considerations

Diprose et al. (2023, p. 23) identify and discuss five key areas of impacts to consider when assessing different organics diversion models:

- Organic waste diversion from landfill/ability to increase processing capacity
- System resilience and diversity
- Proximity, low GHG emission system, and connection between organic material producers and processors
- Building soil/reducing contamination/supporting food resilience
- Job creation and quality.

Based on these areas, the authors set out the anticipated positive impacts/benefits and challenges/considerations for each of the four 'composting service provider' models (pp. 27-28). This framework provides a useful starting point to determine how different models may complement and balance each other.

The following sections discuss a variety of considerations, reflecting how an integrated approach to organics management may help achieve a range of positive impacts/benefits identified in Diprose et al. 2023 (connections to these impact areas are highlighted in bold).

3.1.1 Infrastructure

3.1.1.1 Achieving scale

One of the most commonly cited challenges of distributed local infrastructure is its perceived inability to scale sufficiently to meet organics diversion needs, particularly for cities and densely populated areas. However, it is important to differentiate scalability from economies of scale; home-, small- and medium-scale infrastructure are unlikely to compete with standardised collections and large-scale processing infrastructure on economies of scale. On the other hand, the overall **processing capacity** for an area can be scaled either by building/expanding a large-scale facility on a single-site (scaling-up), or by adding new sites to a distributed network of facilities (scaling-out). Both approaches to scalability require similar conditions to be met - e.g. access to sites, finance, know-how, reliable sources of feedstocks and markets for end products (Diprose et al. 2023, pp. 17-22).

Nevertheless, scaling-out presents particular challenges. Access to land and navigating planning rules/bylaws can be significant barriers for the establishment of new sites where several are required (Diprose et al. 2023, p. 29). The viability of business models of operators running small-scale sites or a localised distributed network (often not-for-profit or social enterprises) has also been cited as a barrier, given the emphasis on social and environmental outcomes rather than economies of scale (ILSR 2022; Weidner et al. 2020, p. 553; De Boni et al. 2022, p. 7). Local government support is crucial to address these barriers (see Section 4).

Networks of OSMS facilities can still achieve significant diversion. Pai et al. (2019) have modelled that the diversion potential for 'backyard' and 'community composting' (at city parks only) in the city of Chicago is 27% (or nearly 80,000 tonnes) of food scraps generated by the city's residents. In local research, Mensah (2017) estimated that 4005 tonnes of organic materials were being composted at homes in Palmerston North at the time of the study. In the US context, it is estimated that 1400-5000 tons (1270-4536 metric tonnes) of organic materials could be diverted for every 10,000 households that are processing this material at home (Platt & Fagundes 2018, p. 6). While some of this material processed at OSMS facilities could be collected at kerbside where collections are made available, much of it is likely to add to, rather than replace, material diverted via kerbside collections.

Ensuring a town/city, district or region has adequate organics processing capacity can be addressed by employing an optimal mix of small, medium and large-scale infrastructure in an integrated regional network (see Diprose et al. 2023; Pai et al. 2019; Weidner et al. 2020; Turnbull et al. 2022, p. 53-55). While the increased complexity of a distributed network approach may require a longer implementation period than relying on a large-scale, single-site processing facility for scale, it will greatly enhance system **resilience** and reap the benefits of maintaining **proximity** between generators and processors of organics, including better control of **contamination** of feedstocks and ease of establishing markets (see more below and Diprose et al. 2023, p. 25). For smaller and more isolated urban centres, large-scale processing may be superfluous to requirements (e.g. Xtreme Zero Waste in Raglan).

3.1.1.2 Quick and flexible implementation

Despite a potentially longer time period to roll out in full, individual components in a network of OSMS infrastructure are comparatively quick to implement with favourable conditions and adequate support (see e.g. Case Study - Besançon on pp.118-119; de Souza & Drumond 2022, p. 12685). This is due to:

- Low tech, cheap and easy to use equipment requiring little training (which can also support **job creation and quality**)
- Minimal space requirements
- Less likely to trigger resource consent requirements/create public nuisance
- Flexibility/adaptability to scale up and/or down, and make mobile/unfixed infrastructure available, depending on context/needs

Further to the final point above, different and **diverse** methods can cater to different circumstances, needs, and wants (see also Pai et al. 2019, p.3). This may provide niche solutions for harder-to-reach communities (e.g. where trucks cannot go) and organics generators (e.g. businesses) and counterbalance the limitations of a one-size-fits-all kerbside collection service (a trade-off for achieving economies of scale). Residents/business who are unable to compost at home/onsite and where local collection is not available or inaccessible, a drop-off site serviced by an operator managing a network of small and medium-scale sites provides the best practicable option.

Such approaches can also be useful for filling gaps where large-scale processing facilities or widespread collections are planned but do not yet exist (boosting interim **processing capacity** and participation/diversion), or where adding local capacity to a distributed network of sites ('scaling out') helps reduce costs of transporting materials to a distant facility (**resilience** and **proximity**).

The flexibility and speed of implementing OSMS infrastructure also enables greater control of **contamination**. The smaller quantities of material flowing through each facility (or the home), combined with the higher degree of manual labour required in low-tech systems, enable more thorough and targeted manual screening and removal of contaminants both pre- and post-processing (Mensah 2017, p. 26; Diprose et al. 2023, p. 18). Large-scale facilities typically require sophisticated and formalised contamination screening and removal technologies that are expensive, not fully effective and may even result in more waste generated (ibid.).

3.1.1.3 Reducing costs and impacts

Reduced infrastructure costs and impacts (particularly greenhouse gas (GHG) emissions) are significant practical benefits of localising organics management. Set-up costs/investments for smaller-scale infrastructure are usually able to be recovered in a shorter period of time compared with large-scale infrastructure (de Souza & Drumond 2022, p. 12685). While equipment for home and smaller scale composting can reduce costs and impacts in part, and can reduce processing burdens from larger facilities, the largest reductions come from the ability to offset material collection/transport logistics due to **proximity** between generators and processors (see Adhikari 2010; Pai et al. 2019; Weidner et al. 2020). This is especially so for home/on-site processing, and where small-to-medium-scale facilities provide highly localised collection or drop-off services that reduce kerbside collection requirements.

Comparative modelling has shown that economising collection logistics (which typically constitute the greatest proportion of a system's overall costs) can substantially reduce costs of organics diversion programs. Scenarios modelled for Canada and groups of European countries showed systems that rely on 'centralised composting facilities' alone (and thus the collection logistics to do so) result in the highest costs, while a model that heavily favours 'home' and 'community composting', but still has 'centralised' facilities playing a role, significantly reduces costs even relative to BAU (organics being sent to landfill) (Adhikari 2010).

Comprehensive modelling applying data from Porto Metropolitan District, Portugal, reached similar conclusions - however, it argues that "regionally integrated biowaste [organics] management plans combining different systems are the best option to achieve cost effectiveness and emissions reduction" (Weidner et al. 2020, p. 561), highlighting that a **diverse** system provides benefits beyond just **resilience**. It also found that population density has a larger impact on collection costs than distance to treatment facilities (p. 557). This may suggest **there is an optimum balance to be struck between achieving economies of scale and reducing costs of logistics**.

While reducing transportation logistics by emphasising **proximity** may help lower transport-related GHG emissions, determining the overall GHG emissions implications of different systems is far more complex. Numerous lifecycle analyses and scientific studies have attempted to quantify and compare the climate impacts of various organics management and processing models, with wide-ranging outcomes. Many variables and assumptions (e.g. calculating energy and fertiliser/feed offsets, process emissions, land application emissions, collection density, proximity etc.) may significantly affect how lifecycle impacts are calculated. A recent Whitepaper by Eunomia (UK) suggests that the greatest climate benefits of organics diversion systems depend on their potential to influence agricultural practices/**food production** and **build soil structure/health**, particularly as energy systems increasingly decarbonise (Sherrington 2023, p. 27)

3.1.2 Adding value

3.1.2.1 In-built markets

The feasibility of organics processing (particularly at scale) depends in large part on markets for its products. This is not nearly as big a challenge for processors operating a network of OSMS facilities, who are typically not burdened by the need to maintain offtake agreements (Pai et al. 2019, p. 2). This is because:

- quantities of compost/products produced at each site are far smaller than those produced by large facilities
- generators of organic material are often also users of the finished product
- processors are often co-located with food production (e.g. home and community gardens, urban, peri-urban and rural farms), creating an instant 'market' or 'sink' that can boost local **food resilience**.

Councils could also support this by purchasing locally-produced compost for parks and greenspace maintenance (see Section 4, also pp. 84-85 in Chapter 1).

Additionally, as users of the finished product are typically involved in collecting (and often generating) feedstocks, they are incentivised to prevent and remove as much **contamination** as possible (though adequate training/education may be required).

Given the variability of product quality and **contamination** control processes of various processing models, councils may wish to employ a marketing strategy that grades products based on quality. This could encourage councils to support small and medium scale operators to follow and demonstrate best practice, and producing high quality products that are marketed as such can support increased revenue generation to subsidise local activity (boosting **job creation and quality**). Having a more **diverse** range of marketable products may also help to increase the **resilience** and economic sustainability of an integrated diversion system.

3.1.2.2 Behaviour change

Researchers and advocates have commented on the tendency for localised organics management, and composting in particular, to support individual behaviour change around source separation/diversion, and preventing/reducing waste generation and contamination (Pai et al. 2019, p. 2; Platt et al. 2014, p. 8; de Souza & Drumond 2022, pp. 12683-12689). This is because of practical factors, such as the close **proximity** of users to processing sites (home or within the neighbourhood/community) that makes the system tangible, and the easy-to-understand process of small-scale composting, as well as enhanced educational outcomes through interactions with local mentors and advocates who can tailor comms to be culturally and demographically appropriate. Even meaningful decreases in the amounts of all types of waste (residual, recycling, organics) generated by service users have been noted in some cases (ibid.).

These factors influencing behaviour change, if effective, may also help increase the rates of participation in other organics diversion initiatives such as kerbside collections (addressed later in this section), and also help raise awareness of the sources and impacts of (and thus reduce) **contamination** of feedstock.

Connection, involvement, empowerment and opportunity
The inherently participatory and interactive nature of smaller scale local initiatives provides a range of social benefits that promote health, wellbeing, cohesion and empowerment. Surveys show that participants of local composting programs emphasise 'leisure' and 'pleasure' above waste reduction as key motivations/outcomes for participating (Lehec 2020, p. 105).[27] Opportunities to connect with nature, learn new skills (e.g. **food production**), and encounter/collaborate with neighbours who may not otherwise interact (made possible by **proximity**) all provide an empowering platform for taking local action to address global problems like climate change (De Boni et al. 2022, p. 2).

Enabling and exposing residents to these positive experiences is an important way to grow public acceptance for organics diversion services, particularly if residents have also been involved in decision-making and design processes for these services (De Boni et al. 2022, p. 2). Participants of home composting workshops/programmes, training courses or volunteer opportunities often become the biggest advocates for diversion services overall. These also create **diverse** new **employment** opportunities in organics diversion, as operators, mentors/trainers, educators, and even pathways into farming, horticulture, landscaping and other related sectors (Platt et al. 2014, p. 11).

3.1.3 Mitigating limitations

3.1.3.1 Poor process

The technical simplicity and quick, low-cost set-up of home and small-scale facilities can lead to negative environmental and community impacts without adequate training in their use. Indeed, the majority of home composting's drawbacks as a technical process is related to poor management (Mensah 2017, pp. 26-27). While odour and leachate releases from small-scale facilities are relatively low risk, these can still be problematic for local communities and ecosystems, particularly if the number and density of poorly managed facilities increases. Such risks are more easily managed at professionally operated processing facilities, and risks are reduced further when facilities are located at an appropriate distance away from residential areas relative to the size of the operation (the odour issues with Christchurch's Living Earth composting facility is an example of why this is important). Training programmes on good management practices are thus essential to ensure the success of any type or scale of organics processing.

Local planning laws often overcompensate for the risks of OSMS facilities by unnecessarily restricting or overly prescribing the types of activities that are/are not permitted (e.g. limiting/restricting the processing of certain materials like food scraps, or requiring a specific process be followed), which can significantly limit opportunities for growing local activity (further discussion in Section 4).

3.1.3.2 Limitations of materials

Inherent limitations of small-scale processing make it difficult to process certain organic materials that have a higher risk of attracting pests and harbouring pathogens (e.g. meat and dairy), or which require equipment such as shredders and/or consistently high temperatures to properly decompose (e.g. shells and bones). While appropriate equipment (e.g. in-vessel composters) and good process (e.g. achieving sufficient temperatures) can enable smaller systems to overcome these feedstock limitations, in most cases these are unlikely (especially at the home-scale and small-scale composting clubs). Kerbside collections supplying large-scale processing facilities can provide an outlet for these more problematic materials, even where individuals prefer to compost at home or at a local community facility (see e.g. Platt et al. 2014, p. 8; Yates 2023). Encouraging this **diverse**

[27] This differs from home composting, for which reducing waste is the primary motivation (UMR 2021, p. 22).

combination may be an important way to boost participation in organics management services (see below).

3.1.4 Participation

3.1.4.1 Challenges

Maximising participation rates is a key issue for organics diversion, and is also a success indicator for organics management services. Such rates typically do not include organics management at home and informal sites that fall outside of local government oversight, but are usually assessed for kerbside collections only. 55-60% has been suggested as a rough average rate based on data from Australia and Germany (Hyder 2012, p. 48), whereas in the UK, rates <35% are considered poor, 35-55% average, and >55% good (WRAP 2021, p. 8). By this measure, NZ's food scraps collection rates currently are at the lower end of 'average' at just over 40% (Yates 2023, p. 1). However, the combined degree of participation in various diversion services and practices, and the potential influence of integrated services on participation more broadly, remain understudied.

Kerbside collections are intended to provide an accessible way to maximise capture of organic materials otherwise going to landfill from residential sources, as a response to barriers that prevent home composting from being widely adopted. These barriers include lack of a garden or adequate space foremost, as well as not generating enough waste for home-scale processing, being put off by smell and 'ick' factor, and a lack of knowledge/know-how. Those already with access to organics collections are also less likely to compost at home (UMR 2021, p. 14). Some of these barriers can be addressed with training or mentoring support, yet overall they suggest that collections are not only a necessary option to increase uptake of organics diversion, but may be preferred by many.

However, similar barriers and behaviours may also account for low participation rates in collections. Recent research on barriers to the use of food scraps collections in NZ identified that a key reason many people may have never used an accessible collection service is because they are already composting/worm farming at home or using alternative disposal methods (e.g. feeding animals, in-sink units). Despite this, they put more food scraps in rubbish bins than they believe they do. Those who have previously used collection services but no longer do were likely put off by smells/flies/maggots etc. or other practical issues (Yates 2023, p. 1). Similar issues were noted in the Wellington City Council 'Para Kai' trial and closing survey, both for collections and home composting (gravitasOPG 2022, pp. 35-38).

Public acceptance and understanding of the benefits of and need for organics services are also recognised as significant influences on participation. This involves a more complex set of social factors such as individuals' sensitivity to environmental issues, degree of involvement in the process, and appreciation of the environmental and economic benefits of collecting and processing organics and its products like compost (Yates 2023; De Boni et al. 2022, p. 7).

3.1.4.2 Boosting participation

Multiple tools exist to address these barriers and factors affecting participation. Relying on communications is a common strategy, and incentives such as compost giveaways have been used to demonstrate the value and circularity of organics diversion (Hyder 2012, pp. 90-93). Undertaking "participatory planning and decision-making, where groups are fully consulted at all stages and on all questions" has also been shown to be particularly effective, although more difficult and time-consuming (p. 33).

Providing practical support (e.g. equipment, sites, training, and "paid and locally engaged technical personnel") is suggested to be more effective at increasing participation in schemes (and addressing other issues such as **contamination** and good process) than simply communications and incentives

(Weidner et al. 2020; de Souza & Drumond 2022, p. 12687). Common practical improvements that have shown to help increase participation in collections include ensuring that they are low cost, convenient (e.g. more frequent organics and less frequent rubbish collections), that they supply equipment like kitchen caddies and compostable liners, and are supported by ongoing and multimedia communications (Hyder 2012, p. 48; Yates 2023, p. 27). Additional improvements recommended in the NZ food scraps collection use research include: alternative bin designs, bin cleaning services, and offering combined food and garden organics (FOGO) bins (Yates 2023, p. 39). Drop-off sites may also provide another option where collections and onsite processing are inaccessible/not feasible (although drop-off options present their own barriers to participation based on their location and users' willingness to travel there, which could result in disproportionately greater GHG emissions if locations are not ideal. See Pai et al. 2019, p. 3).

However, improvements to collections themselves will only help address participation barriers for those who no longer use the service because of practical issues and the 'ick' factor, not for those who already use an alternative disposal method. The food scrap collection use report concludes:

> **"It may not be effective to attempt to get households that already compost or feed scraps to animals to switch to using the food scraps collection. Instead, these households could be encouraged to compost/feed animals more food scraps or use the food scraps collection for excess or unwanted food scraps" (p. 40).**

This recommendation highlights an opportunity for home and local processing support programmes not only to improve diversion outcomes for those who do not use collections, but also as another channel for communication/education strategies to boost participation and overall diversion. In an ILSR webinar, the Director of Compost Programs and Partnerships at New York City's (NYC) Department of Sanitation (DSNY), Debbie Sheintoch, has described how areas of NYC with more numerous 'Master Composters' (graduates of composting training programme) and food scraps drop-off sites have seen an increase in participation of the City's kerbside collection service (ILSR 2022), indicating the capacity for these different offerings to be mutually reinforcing.

As discussed earlier, localised initiatives have the potential to create behaviour change in ways collection services and communications alone are unlikely to. De Boni et al. (2022) describe how 'community composting' involves active bottom up participation, collaborative and direct learning, connection with nature, and creates a reinforcing loop for participation. The more direct and frequent human interactions provide more opportunity to increase awareness about positive and negative impacts related to the food and waste sectors, and how certain behaviours (which are modelled and seen in action) can improve or worsen these impacts.

Local, 'human-scale' initiatives offer a direct experience of why separating and processing organics is important, the value of doing so, and how individuals can actively contribute. Such initiatives also provide the opportunity for individuals to get hands-on experience of handling food scraps and managing the natural processes of decomposition, which can help confront and transform feelings of disgust (the 'ick' factor) to feelings of awe, wonder and appreciation (Morrow & Davies 2020, pp. 540-541). These all help mitigate the 'out of sight, out of mind' nature of collection services that transport material to distant facilities, which is linked to the public's lack of awareness of the importance and benefits of organics diversion (see Schlesinger 2016).

To realise these benefits for maximising participation, councils should strategically integrate various levels of service. Implementing something like a 'Master Composter' programme may be a centrepiece of such a strategy (see Appendix and Section 4 for more detail), and procuring an enterprise(s) to deliver this programme alongside managing and supporting OSM collections, drop-offs and processing facilities, will provide **diverse** options that cater to those who will/do not use collections, while providing human resources that operationalise and localise communications programmes, and help enhance participation in collections.

Case Study: New York City

The New York Department of Sanitation (DSNY) has long pursued a "multi-tiered organics diversion strategy that includes curbside composting, community composting, drop-off composting, as well as backyard and home composting" (ILSR 2022, 1:01:40). The DSNY's NYC Compost Project, founded in 1993, does a lot, including: public outreach and engagement opportunities (e.g. volunteer programmes, tours and school visits), education and communications, a Master Composter training course, technical assistance to 'community composting' sites, and compost distribution, alongside its collection and processing activities.

In 2012 the NYC Compost Project started an operational arm that partners with local organisations (some of which were already in operation) to run 6 'mid-scale' composting sites processing several hundreds of tonnes of organic material each. The material for these sites, and small-scale 'community' sites, are largely obtained via a network of over 200 drop-off sites hosted at both council and community sites, which are managed/collected from by partner organisations. These services sit alongside the DSNY's expanding food and garden organics kerbside collection services, which take these materials to large-scale regional processing facilities.

DSNY's 'multi-tiered' approach is partly a response to the challenges that NYC's highly diverse population and densely populated urban area presents to participation in its organics diversion services. Kerbside collections do not suit the city's numerous highrise apartment blocks, but in its absence, the demand for and provision of drop-off sites continues to grow. DSNY's comprehensive suite of outreach and education programmes, the heart of which is the Master Composter course, provide community-oriented touchpoints that help tailor and increase access to services for harder-to-reach communities (e.g. non-English speaking and minority communities, individuals with a physical disability) and increase participation. These programmes have been described as the 'retail arm' of composting in NYC.

NYC's approach to organics diversion provides a great example of multiple integrated services working together and supporting each other. Many of the partner organisations that have driven the success of the project have been established by graduates of the Master Composter course, and would be unlikely to survive or thrive without the direct support from DSNY.

For a more detailed summary, see the ILSR's webinar, 'Government Support for Community Composting Part 1: Spotlight on New York City' (ILSR 2022).

4 Supporting and integrating local organics diversion

Getting the most out of integrating various types of organics diversion services and activities for the Waikato Region, and across Aotearoa New Zealand, requires a clear picture of what such combinations might look like, and an understanding of the range of targeted support measures that create favourable conditions. Support is particularly important for OSMS activities; they frequently emerge from grassroots, community-led initiatives (hence the common label 'community composting'), which may rely on voluntary labour, donations, free use of land etc. This can make navigating policies and planning rules difficult and overly burdensome. In addition, such processing sites may not be adequately managed or have trained personnel, and they can struggle to grow a successful small-scale community project into a financially sustainable and competitive social enterprise. These challenges should not be seen as inherent limitations of OSMS initiatives, but as symptoms of unfavourable local conditions (e.g. market failure, a prohibitive regulatory framework, lack of professional training and capacity building opportunities), and a failure to recognise the wide ranging social, ecological, cultural and economic value of community and social enterprise.

This section begins by exploring the key policy and support levers to make conditions for OSMS activities more favourable. This looks at by-laws and planning rules, training and assistance, land, facilities and equipment, and funding and procurement. Following this discussion, a series of four basic scenarios for integrating localised organics management into a wider ecosystem of services is presented. These scenarios are mapped onto demographic contexts across the Waikato Region, and case studies and examples are given for each scenario.

4.1 Policy & Support

While diverting organics from landfill is a top policy priority in the government's waste work programme, there remains little policy guidance for how local government - who are ultimately tasked with implementing much of this work - can support a diverse range of organics diversion services. A range of relevant policies and bylaws, some set by central government, can affect the (un)favourability of organics diversion in general, not just OSMS approaches. These include: pay-as-you-throw (PAYT), mandatory separate collection, bans/restrictions or targets to reduce disposal of organics in landfill, and a waste disposal levy (Daskal et al. 2022, pp. 5-6). However, these do not address the different circumstances and needs of smaller scale activities to enable their operation.

This section highlights several considerations and actions for local government to support OSMS activities, to reduce barriers and create an environment in which they can thrive, while ensuring there are adequate protections for environmental and public impacts. Many of the points raised in this section draw on international guides and studies - see Appendix for more detail.

4.1.1 By-laws and planning rules

Navigating local planning rules, consenting issues and bylaws can be a major challenge for social enterprises and community organisations wanting to do organics processing, particularly those who manage multiple sites (Diprose et al. 2023, p. 29). Such policies are usually designed to mitigate the proportionately larger impacts of large-scale facilities based at a single site. Furthermore, rules and policies specific to smaller-scale activities in some jurisdictions (e.g. capacity and space limitations/requirements, process prescriptions) can be overly restrictive in seeking to prevent or minimise environmental and nuisance impacts (Daskal et al. 2022, pp. 6-8; Lehec 2020, p. 102).

To avoid being overly restrictive, local bylaws and planning rules should focus on specifying the outcomes and impacts that must be avoided (e.g. odour, leachate, and other nuisance or environmental effects) without prescribing specific practices. This is recommended by the ILSR, and is also the approach taken in the United States Composting Council's (USCC) 'Model Law' (USCC 2022, p. iii). The ILSR also recommends including catch-all provisions in rules or bylaws that circumvent any unforeseen restrictions on organics processing - e.g. a clause specifying that nothing in the bylaw or rules should prevent people from composting or processing organics by default (Platt & Fagundes 2018, p. 43).

The USCC's Model Law (see Appendix), although designed for the US context, is nonetheless a useful set of policy considerations and provisions that could be applied in Aotearoa New Zealand with adaptations. Section 3 outlines a range of exemptions to the rules that could be applied for certain types, feedstocks and scales of organics processing that are low risk, which includes home ('backyard') composting and small-scale facilities. The remainder of the document provides increasingly restrictive requirements primarily based on the types of feedstocks (lower to higher risk) processed, and some general provisions around siting, testing, reporting, training and certification, and operations plans. Depending on how exemptions are set, it may be appropriate for these requirements to apply to 'medium-scale' facilities.

A requirement that may be worth applying to all types of facilities, regardless of size or exemption status, is for the involvement of trained personnel. Requiring composting clubs or small-scale sites to be managed (or at least mentored) by trained/qualified personnel is an effective way of mitigating environmental and nuisance impacts. Individuals or organisations wanting to receive support (e.g. subsidised equipment) for home or onsite processing could be required to undertake basic training or mentoring, or at least if they are found in breach of environmental and nuisance rules.

4.1.2 Technical assistance, training, staffing and other programmes

Overcoming common challenges/pitfalls of home-based and small-scale localised practices (see Section 3) can be addressed by training and employing personnel to provide technical assistance (Weidner et al. 2020, p. 553). This support should involve regular on-site assistance and mentorship, as well as ongoing online or on-call troubleshooting. Personnel could include a mix of paid council employees or qualified graduates of training programmes (e.g. Master Composter courses), who might also manage processing sites on public land, and trained volunteers in certain circumstances.

'Master Composter' or 'train the trainer' type programmes, funded by local governments, are central to the success of localised composting and, often, organics diversion strategies more broadly. While the primary purpose of a Master Composter programme is to provide training in compost management skills, mentorship and education for localised activities, graduates are usually the greatest ambassadors for organics diversion services, helping to increase access, visibility and participation for kerbside collections and identifying (and filling) gaps in services by recommending or even starting new initiatives (see New York case study). For more information on these programmes, see ILSR guides and webinars, WRAP guide in Appendix.

Demonstration sites are essential for training programmes, workshops etc. and councils can support the establishment of these (e.g. by providing public land or resourcing set-up and running costs).

4.1.3 Land, facilities, equipment, ingredients

Access to land and security of tenure have been identified as key barriers for smaller-scale and distributed organics processing networks, and where possible, providing land (at unused/underutilised sites) is one of the most important ways local authorities can help overcome these barriers (Platt et al. 2014, p. 73; Diprose et al. 2023, p. 29). Hosting demonstration sites on public land and organic material drop-off sites at public facilities, or providing space for storage of material/equipment are also simple ways councils can remove barriers for small social enterprises. Councils could also consider converting disused or underutilised public land/facilities into urban farms/community gardens to increase the "local sink capacity" of compost and other products, ensuring organic materials are cycled locally and support local food production and resilience (Weidner et al. 2020, p. 553).

Providing equipment for home composting or small-scale community sites can drive their uptake, and more effectively boosts participation than just providing information and incentives (de Souza & Drumond 2022, p. 12687). Offering several equipment options for home/onsite processing is important to achieve this, and there are several considerations/options for how they are procured and supplied: whether to subsidise, sell at wholesale price, or provide free; require residents to pre-order and buy in bulk when sufficient demand; provide vouchers instead of equipment directly; and arranging accessible pick-up locations for equipment or have them delivered. These all have different implications for cost, administration burden, and participation - e.g. some actions that increase participation will cost more and risk excess purchases of equipment that don’t get used (Platt & Fagundes 2018, pp. 28-30).

In addition, council parks maintenance teams who have access to consistent ‘browns’ or bulking material (such as wood chip/arborist mulch) can supply this/make available for free to home composters and localised processors.

4.1.4 Funding, contracting, and procurement

While home composters and volunteer-run composting clubs can usually function without the need for financial assistance beyond small grants, service providers operating a network of sites typically use labour-intensive, low-tech systems and may rely on financial assistance to maintain or expand their operations. One-off grants can help cover capital costs of establishing or expanding sites, but operational expenses typically require ongoing or contract funding - this was acknowledged as a common need in a 2022 survey of composters in NZ (Diprose et al. 2023, p. 30). While some operators may be able to generate revenue from services to private business, procuring these operators as public service providers with multi-year contracts or agreements is an important way to ensure their ability to maintain a consistent level of service to residents and to support an integrated diversion strategy.

However, having multiple sites and potentially multiple providers across a distributed network of sites has the potential to create administrative complexity for formal/contractual relationships and agreements. Borlotti et al. (2018) have noted that the diversity of ‘decentralised’ systems means that robust and accessible communication channels between service providers, users, institutions (e.g. local government) and the market are essential to manage this complexity (pp. 516-517). This complexity could be navigated by, for example, procuring a single enterprise (or as few as possible) to manage OSMS networks across defined areas, and/or requiring such enterprises and large-scale commercial providers to partner or have shared responsibilities/accountabilities.

A promising model for such ventures is the development of Auckland’s resource recovery network of ‘community recycling centres’ (CRCs) and zero waste hubs. These initiatives involve agreements between community-led enterprises and Council to run specific centres, with the zero waste enterprise, Localised, being a joint venture partner with some CRC enterprises, providing the necessary professional experience to access procurement, capital, and support for capacity building, management and governance.

Auckland Council have been using the establishment of this resource recovery network to develop and implement approaches to social procurement. This has included providing ‘funding agreements’ instead of service contracts for running CRCs, which not only helps to reduce the tendering burden and insurance hurdles for community organisations, but also bypasses the need to be overseen by a contract manager and assessed against KPIs. Additionally, the involvement of Localised, who also run zero waste hubs that warehouse and redistribute resources from Auckland’s inorganic collection, provides Auckland Council with the security of a reliable and experienced resource recovery operator to help reduce and manage risks associated with social procurement.

While there are few examples of such formal relationships between local government and OSMS organics diversion enterprises in Aotearoa New Zealand,[28] the case studies in this Chapter (New York and Besançon) are notable international examples. Both demonstrate local government entities who have procured organics service providers to operate medium-scale sites, collections, and drop-off networks, and/or manage, support, and mentor the operation of small-scale community-based, onsite and home-based processing facilities. See the ILSR's webinar series *Government Support for Community Composting* (in Appendix) for more ideas, cases and examples of such arrangements.

Another way councils can support operator revenue is to guarantee the purchase of compost/products for use by council staff in public parks and green spaces. With such a guarantee, local providers could be incentivised to create products suited to council use (see pp.84-85 in Chapter 1).

4.2 Possible scenarios for integration

What would an integrated organics management system look like? The answer is there is no single model, no one size fits all. Each community, town, city, district, and region will have specific circumstances, demographics, geographics and influences that will shape the possible outcomes. Thankfully, there are existing models and studies to draw on that help demonstrate what feasibly can be done, and what might produce positive outcomes for specific contexts.

Below are brief descriptions of a range of possible scenarios for integrating OSMS activities with kerbside collection and large-scale processing systems. Different scenarios are presented for four demographic/geographic contexts, based on population size and geographic spread. These scenarios differ from, but draw on elements of, the New York and Besançon case studies presented earlier in this Chapter. They also reference some Aotearoa-specific models operating OSMS services.

These scenarios presented for each population size and spread are only indicative; they should not be considered exhaustive, nor exclusive to the demographic context.

4.2.1 Four demographic scenarios

4.2.1.1 Large population, densely populated (e.g. Hamilton)

This type of scenario may depend on one or more large-scale facilities to provide adequate processing capacity for the population, but OSMS activities and services could be important to boost local capacity and engagement/participation, and fill niches not suited to standardised collection services. Maps onto New York case study, and Chicago study (Pai et al. 2019).

- Kerbside collection sending material to large-scale facility/facilities outside city
- OSMS activities serving businesses and/or organic material streams not well served by residential kerbside (e.g. MUDs, and harder-to-reach communities/generators of organic materials)
- A proportion of material collected at kerbside (e.g. 20-30%) could be allocated to small-medium-scale processing facilities, or some defined collection areas designated to local providers. Need to specify in collection contracts:
    - One contract as a partnership between small, medium and large providers, or
    - Multiple contracts for different portions of the material streams

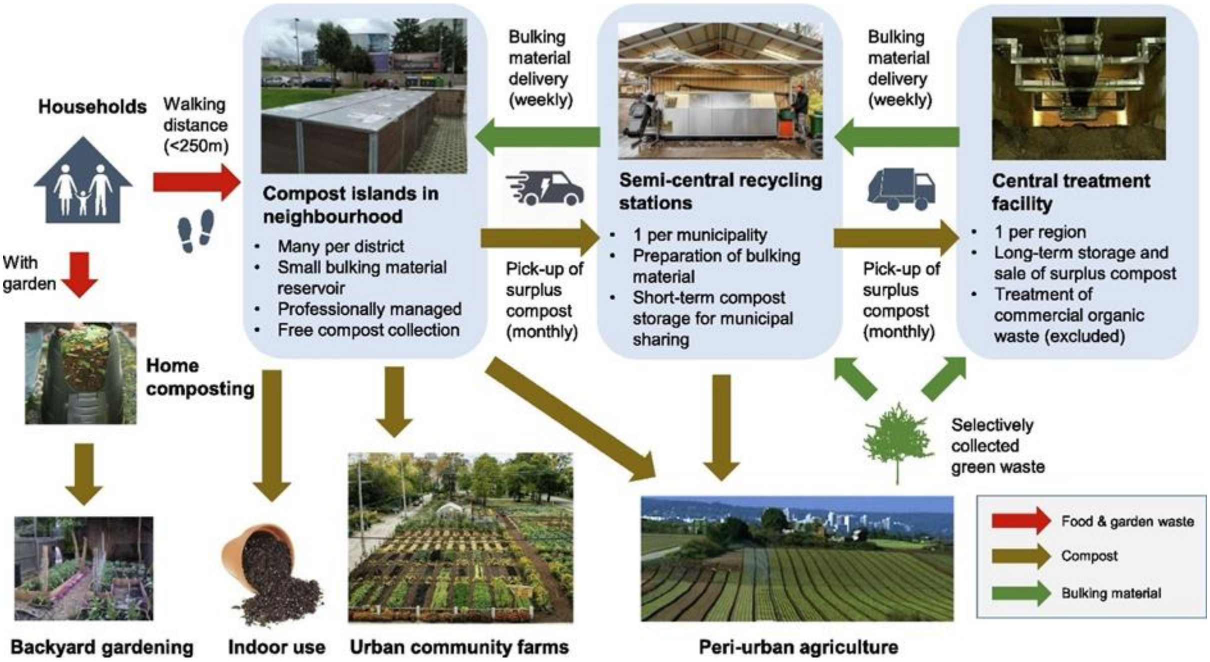
[28] A notable exception is Xtreme Zero Waste, who provides a food scraps collection service for Whāingaroa/Raglan on behalf of Waikato District Council. This is a locally-bound service and considered a medium-scale activity.

- Local service providers delivering education, comms and outreach services etc. to enhance both local processing (e.g. home/onsite) and participation in kerbside collections

4.2.1.2 Large population, spread over wide geographic area (a collaborative regional approach between multiple Councils, e.g. Hamilton, Waipā, Waikato, Matamata-Piako)

This scenario would benefit from a comprehensive, distributed network of multiple providers and scales. Large-scale facilities will likely be needed, but may play less of a central role compared to the above scenario. Maps onto Porto region study (Weidner et al. 2020).

- Large-scale facility/facilities receiving material from source-separated collections in the most densely populated areas, and providing back up capacity for low-density townships.
- Local OSMS collections and facilities serving towns and more sparsely populated areas, and providing additional capacity for harder-to-reach communities and those not participating in standardised collections.
- Local service providers delivering education, comms and outreach services etc. to enhance both local processing (e.g. home/onsite) and participation in kerbside collections.



Basic diagram of integrated model from Weidner et al. 2020, p. 555

4.2.1.3 Small population, spread over wide geographic area (Waitomo, Ōtorohanga, South Waikato, Thames-Coromandel, Hauraki; Taupō District)

Collecting and sending material to a large-scale facility is unlikely to be a sensible option (in terms of costs and emissions) in this scenario, where small settlements could be served by strategically placed and coordinated small and medium scale processing sites and localised collections. Maps onto Austria model (see Diprose et al. 2023, p. 31; Prince 2021, pp. 9-10).

- Distributed, coordinated network of small & medium scale sites across rural areas.
- Opportunity to use farms as processing sites for material collected from nearby settlements, or home/onsite and small scale options within settlements.
- Network operators managing multiple sites, collection areas and outreach/education could simplify accountability/contracting, or partnering with local community organisations for some services (especially education, comms and outreach services).
- Regional large-scale facility could provide back-up capacity as a last resort.

4.2.1.4 Small population, densely populated (e.g. Taupō urban area, Cambridge, Tokoroa, Te Awamutu, Huntly, Morrinsville, Raglan etc.)

This scenario involves individual towns (or nearby settlements working together) that are far from larger centres implementing a 'right-sized' service for their area, such as Xtreme Zero Waste serving the township of Raglan (see case study below). Also maps onto Queenstown Lakes District Council approach to organics management (see QLDC 2023).

- Local organics service providers manage small and medium-scale collections and processing sites, and deliver education, comms and outreach services etc., within or close to towns/cities.
- A medium-scale service to provide appropriate economies of scale.
- Onsite and small-scale activities can supplement medium-scale facilities.

Case Study: Xtreme Zero Waste, Raglan

Xtreme Zero Waste (XZW) operates a community resource recovery centre and is a recycling and landfill waste service provider contracted by Waikato District Council. XZW has been operating in Whāingaroa/Raglan since the year 2000 and provides these services to the small urban area of Raglan township and the rural community within the Whāingaroa Harbour catchment with a total population of around 10,000 people. They have achieved landfill diversion rates consistently above 70% since the year 2000 while providing local employment and economic wellbeing.

Waste minimisation has been an important part of XZW's strategy for the last 23 years and drives the community effort towards zero waste, using the waste hierarchy to guide decision making and focus. The relatively small community they serve, as well as the community-led nature of the organisation enables effective, direct, and tailored channels of communication between residents and XZW to minimise waste, reuse, and recycle well - including reducing contamination in collections. Their efforts have generated strong levels of support for XZW's services and zero waste initiatives in the Raglan community, and XZW is seen as a leading model of a community-led, local-scale resource recovery centre/zero waste hub in Aotearoa.

XZW have provided food scraps collections and composting for Raglan since 2017. The collected food scraps are mixed with garden/green waste and processed over 10-12 weeks in a 30m long 'Horizontal Composting Unit' (HCU), a mostly in-vessel system with moving lids (enabling mechanical turning using a digger) and internal drainage. The compost from the HCU is sifted and matured, before being made available for sale as a range of compost products, ensuring that the material both coming in and leaving the site remains local. XZW's composting system is considered 'medium-scale', processing roughly 300 tonnes of organic material per year. XZW also composts garden waste separately in windrows, processing another 300 tonnes of organic material and enabling a high level of diversion of the total organic waste stream in Whāingaroa/Raglan.

5 Conclusion

There are many ways to implement an integrated approach to organics management that includes OSMS locally-based systems. The Waikato region is varied and extensive; by drawing on the strengths of existing infrastructure and providers who use a variety of approaches (many of which are responsive to local context), there is an opportunity to pilot several different models of integrated organics management in this region as outlined in Section 4. Regardless of how it is approached, recognising the complementarity of different levels of service/activity and playing to their strengths, rather than seeing different activities as competing or incompatible, could help achieve a wider range of positive outcomes discussed in Section 3 than can be achieved by pursuing a single system or approach alone. While there are many potential and perceived barriers to implementing an integrated system - e.g. cost, complexity, unfamiliarity, and conflicting with the principle of a single service model (Lehec 2020) - they are not insurmountable.

This chapter attempts to demonstrate that the pros outweigh the cons in pursuing an integrated approach. Understanding the different types/definitions of OSMS services and systems described in Section 2 will make it easier for councils, communities, iwi/Māori, and businesses to identify appropriate services and activities that can meet specific local needs/aspirations, and fill gaps in standardised services while also supporting their uptake. Creating favourable conditions by putting the right policy framework in place (drawing on the discussion in Section 4) will be key to maximising the benefits of an integrated approach. By taking the best from examples in Aotearoa and around the world, this chapter presents the Waikato region with the tools to create a leading model of a circular (bio)economy for organic materials in Aotearoa New Zealand.

Appendix A - Tools & Resources

International guides & reports

1) Home composting guides:
    a) https://wrap.org.uk/resources/guide/waste-prevention-activities/garden-waste/home-composting
    b) https://ilsr.org/wp-content/uploads/2018/06/Yes-In-My-Backyard-Full-Report-v2.pdf

2) 'Community composting' guides/reports:
    a) Brenda Platt, James McSweeney and Jenn Davis 2014. Growing Local Fertility: A Guide to Community Composting. Institute for Local Self-Reliance (ILSR). https://ilsr.org/wp-content/uploads/2014/07/growing-local-fertility.pdf
    b) Webinar series: https://ilsr.org/govt-support-for-community-composting-series/
    c) ILSR 2022. 'Webinar: Government Support for Community Composting Part 1: Spotlight on New York City.' https://ilsr.org/govt-support-for-community-composting-nyc/
    d) Community composting census: https://ilsr.org/composting-2022-census/

3) Communications guides:
    a) US EPA social marketing toolkit: https://www.epa.gov/sustainable-management-food/forms/composting-food-scraps-your-community-social-marketing-toolkit

Aotearoa New Zealand Guides, Training & Support

There are many great guides and resources on 'how to compost' provided by dedicated organisations throughout Aotearoa. Many councils also have useful resources available on their websites that you may find useful. Here is a list of some of them, please note: this list is not exhaustive.
**Note: As Aotearoa continues to implement the new Waste Strategy there will continue to be increased support and guidance coming from Ministry for Environment, be sure to connect into what is being put out by them.*

1) Home compost guides
   a) https://carboncyclecompost.com/the-carboncycle-composting-guide/
   b) https://www.stratford.govt.nz/our-services/rubbish-and-recycling/your-guide-to-composting

2) Composting enterprise guides:
   a) Zero Waste Network Training on Community Compost Set Up
      https://zerowaste.co.nz/training-2/organics/

Aotearoa New Zealand Organisations providing support

Throughout the country there are national and local organisations that provide support from home composting through to waste diversion initiatives. Some key ones operating in the organics space are listed below. It is highly recommended that you do some research into what is happening in this space locally for you to connect in with groups/organisations that may be able to provide you with the support you need.

1) **National**

   a) Para Kore
      A Māori not-for-profit organisation working towards zero waste. Providing support and educational programmes.
      https://www.parakore.maori.nz/

   b) Zero Waste Network
      Network representing community enterprises across Aotearoa New Zealand who are working towards zero waste. Provide, relevant research, training and resources as well as a space to connect and advise.
      https://zerowaste.co.nz/

   c) Localised
      Provide practical support in being a joint venture partner in new or expanding initiatives in the resource recovery sector of Aotearoa
      https://www.localised.nz/

   d) Love Food Hate Waste
      Work with councils and community groups to reduce food waste (top of the waste hierarchy)

https://lovefoodhatewaste.co.nz/

e) Share Waste
A Compost Collective initiative that provides a platform for individuals and households to share food & garden waste with neighbours who are processing it.
https://www.sharewaste.org.nz/

f) Carbon Cycle Compost
Company providing a scalable hot compost system for individual and community use.
https://carboncyclecompost.com/the-carboncycle-system/

2) **Regional**

a) Compost Collective
Online resources to help individuals reduce food & garden waste
https://compostcollective.org.nz/

b) Community Compost
Provide an urban community compost system (collection & composting) as well as compost systems design and consultation for neighborhoods, towns, cities or regions.
https://communitycompost.co.nz/about-us

c) Xtreme Zero Waste
The Whāingaroa community zero waste programme that has been working hard for the last 22 years to achieve a 75-80% diversion of waste from landfill. Provide online learning, site visits and insights.
https://xtremezerowaste.org.nz/

3) **NZ Councils offering support for home composting alongside organics collections**

a) Home composting guidance:, provides some info on home composting on website (Factsheets/guides for composting, worm farming, bokashi)
   i) Tauranga
   ii) Christchurch
   iii) Selwyn
   iv) Western Bay of Plenty
   v) New Plymouth

b) Waimakariri offers discounted bokashi products

c) Queenstown Lakes DC offer subsidised bokashi and worm farming

d) Tauranga & WBOP offer composting workshops where there is demand

e) New Plymouth provide info/guidance, and support Sustainable Taranaki to run composting workshops and provide discounted equipment

Policy

1. US Composting Council (USCC). 2022. Model Compost Rule Template. https://cdn.ymaws.com/www.compostingcouncil.org/resource/resmgr/documents/Model_Compost_Rule_Template_.pdf

NZ reports

1. Research into barriers to use of food scraps collections. Prepared by Sunshine Yates Consulting for MfE: https://environment.govt.nz/assets/publications/Waste/Research-into-barriers-to-use-of-food-scraps-collections.pdf
2. General public attitudes to composting and compostable packaging – survey report. Prepared by UMR for MfE: https://environment.govt.nz/assets/publications/General-public-attitudes-to-composting-and-home-compostable-packaging-Survey-report.pdf
3. Scaling-up, scaling-out & branching-out: Understanding & procuring diverse organic materials management models in Aotearoa New Zealand. Prepared by Manaaki Whenua Landcare Research and Zero Waste Network. https://zerowaste.co.nz/resource_library/organics-models-in-aotearoa-nz/
4. Para Kai Trial: Phase Two Survey - End of Trial: Final Report. Prepared by gravitasOPG for Wellington City Council: https://wellington.govt.nz/-/media/rubbish-recycling-and-waste/reducing-your-waste/para-kai-miramar/files/para-kai-trial--phase-two-survey--report-final-april-2022.pdf?la=en&hash=65AA1ACBF9C58F040307A8508DE2959824241471
5. Taranaki Region Organic Materials Recovery Feasibility Study Options Assessment Report. Prepared by Tonkin & Taylor for South Taranaki District Council, New Plymouth District Council, Stratford District Council: https://www.southtaranaki.com/repository/libraries/id:27mlbegko1cxbyf94es5/hierarchy/Documents/Plans%2C%20strategies%20and%20reports/Environment%20and%20Sustainability/Tonkin%20and%20Taylor%20Organics%20Feasibility%20Report%20%28FINAL%29%20-%202022%2006%2017.pdf

Academic Papers

Adhikari et al. 2010. Home and community composting for on-site treatment of urban organic waste: perspective for Europe and Canada. https://doi.org/10.1177/0734242X10373801

Borlotti et al. 2018. Decentralised Organic Resource Treatments – Classification and comparison through Extended Material Flow Analysis. https://doi.org/10.1016/j.jclepro.2018.02.104

Daskal et al. 2022. Decentralized Composting Analysis Model—Benefit/Cost Decision-Making Methodology. https://doi.org/10.3390/su142416397

De Boni et al. 2022. Community composting: A multidisciplinary evaluation of an inclusive, participative, and eco-friendly approach to biowaste management. https://www.sciencedirect.com/science/article/pii/S266678942200023X

de Souza & Drumond 2022. Decentralized composting as a waste management tool connect with the new global trends: a systematic review. https://doi.org/10.1007/s13762-022-04504-1

Lehec 2020. Alternative Techniques to Large Urban Networks: The Misunderstandings about the Success of On-Site Composting in Paris. https://doi.org/10.1080/10630732.2020.1814650

Morrow & Davies 2020. Creating careful circularities: Community composting in New York City. https://doi.org/10.1111/tran.12523

Pai et al. 2019. Decentralized community composting feasibility analysis for residential food waste: A Chicago case study. https://doi.org/10.1016/j.scs.2019.101683

Sabina Mensah 2017. DEVELOPMENT AND TRIAL OF A METHODOLOGY FOR THE QUANTIFICATION AND EVALUATION OF HOME COMPOSTING IN PALMERSTON NORTH, NEW ZEALAND. Masters Thesis. http://hdl.handle.net/10179/12437

Schlesinger 2016. Pop-Up Compost Project: Reframing the processes and perceptions of community composting in New Brunswick, NJ. Master Thesis https://www.proquest.com/docview/1844418146?fromunauthdoc=true

Weidner et al., 2020. Comparison of local and centralized biowaste management strategies - A spatially-sensitive approach for the region of Porto. https://doi.org/10.1016/j.wasman.2020.09.013

Appendix B - References

Adhikari BK, Trémier A, Martinez J, Barrington S 2010. Home and community composting for on-site treatment of urban organic waste: perspective for Europe and Canada. Waste Management & Research 28 (11): 1039-1053. https://doi.org/10.1177/0734242X10373801

Borlotti A, Kampelmann S, De Muynck S 2018. Decentralised Organic Resource Treatments – Classification and comparison through Extended Material Flow Analysis. Journal of Cleaner Production 183: 515-526. https://doi.org/10.1016/j.jclepro.2018.02.104

Daskal S, Asi O, Sabbah I, Ayalon O, Baransi-Karkaby K 2022. Decentralized Composting Analysis Model—Benefit/Cost Decision-Making Methodology. Sustainability 14(24): 16397. https://doi.org/10.3390/su142416397

De Boni A, Melucci FM, Acciani C, Roma R 2022. Community composting: A multidisciplinary evaluation of an inclusive, participative, and eco-friendly approach to biowaste management. Cleaner Environmental Systems 6: 100092. https://doi.org/10.1016/j.cesys.2022.100092

de Souza LCG, Drumond MA 2022. Decentralized composting as a waste management tool connect with the new global trends: a systematic review. International Journal of Environmental Science and Technology 19: 12679-12700. https://doi.org/10.1007/s13762-022-04504-1

Diprose G, Levenson E, Booth P, Prince L, Blumhardt H 2023. Scaling-up, scaling-out & branching-out: Understanding & procuring diverse organic materials management models in Aotearoa New Zealand. Report by Manaaki Whenua Landcare Research and Zero Waste Network. 36 p. https://zerowaste.co.nz/resource_library/organics-models-in-aotearoa-nz/ (accessed 28/11/2023)

Hyder 2012. Food and Garden Organics: Best Practice Collection Manual. Prepared for the Department of Sustainability, Environment, Water, Population and Communities. Canberra, Australian Government. 158 p. https://www.awe.gov.au/sites/default/files/documents/collection-manual.pdf (accessed 28/11/2023)

ILSR 2022. Webinar: Government Support for Community Composting Part 1: Spotlight on New York City. https://ilsr.org/govt-support-for-community-composting-nyc/ (accessed 27/11/23)

Lehec E 2020. Alternative Techniques to Large Urban Networks: The Misunderstandings about the Success of On-Site Composting in Paris. Journal of Urban Technology 27 (3): 93-113. https://doi.org/10.1080/10630732.2020.1814650

Libertelli C, Platt B, Matthews M 2023. A Growing Movement: 2022 Community Composter Census. Institute for Local Self-Reliance report. 26 p. https://ilsr.org/composting-2022-census/ (accessed 27/11/23)

Mensah S 2017. Development and trial of a methodology for the quantification and evaluation of home composting in Palmerston North, New Zealand. Unpublished Master of Environmental

Management thesis, Massey University, Palmerston North, New Zealand. http://hdl.handle.net/10179/12437

Morrow O, Davies A 2020. Creating careful circularities: Community composting in New York City. Transactions of the Institute of British Geographers 47 (2): 529-546. https://doi.org/10.1111/tran.12523

Pai S, Ai N, Zheng J 2019. Decentralized community composting feasibility analysis for residential food waste: A Chicago case study. Sustainable Cities and Society 50: 101683. https://doi.org/10.1016/j.scs.2019.101683

Platt B, Fagundes C 2018. YES! IN MY BACKYARD: A home composting guide for local government. Institute for Local Self-Reliance report. 90 p. https://ilsr.org/yimby-compost/ (accessed 27/11/23)

Platt B, McSweeney J, Davis J 2014. Growing Local Fertility: A Guide to Community Composting. A Collaboration Of Highfields Center For Composting And The Institute For Local Self-Reliance Report. 121 p. https://ilsr.org/wp-content/uploads/2014/07/growing-local-fertility.pdf (accessed 27/11/23)

Prince L 2021. Expanding Organic Waste Collections and Composting in Aotearoa. Prepared by The Rubbish Trip for Greenpeace Aotearoa. 37 p. https://www.greenpeace.org/static/planet4-aotearoa-stateless/2021/09/0e47a063-expanding-organic-waste-collections-and-composting-in-aotearoa.pdf (accessed 28/11/2023)

QLDC 2023. Queenstown Lakes Community Composting Project. Queenstown Lakes District Council. https://www.qldc.govt.nz/services/rubbish-recycling/other-waste/green-and-food-waste/queenstown-lakes-community-composting-project (accessed 13/12/2023)

Schlesinger AP 2016. Pop-Up Compost Project: Reframing the processes and perceptions of community composting in New Brunswick, NJ. Master of Landscape Architecture thesis, The State University of New Jersey, New Brunswick, USA. https://www.proquest.com/docview/1844418146?fromunauthdoc=true (accessed 28/11/2023)

Sherrington C 2023. Reimagining the Waste Framework Directive: An EU Regulatory Framework for a Circular Economy consistent with 1.5 degrees. Eunomia, 32 p. https://www.eunomia.co.uk/reports-tools/reimagining-the-waste-framework-directive/ (accessed 28/11/2023)

SYBERT 2022. Rapport Annuel 2022. Besançon, SYBERT. 32 p. https://www.sybert.fr/wp-content/uploads/2023/06/RA_2022_RVB_LIGHT.pdf (accessed 28/11/2023)

Turnbull C, Ainsworth A, Purchas C 2022. Taranaki Region Organic Materials Recovery Feasibility Study Options Assessment Report. Prepared for South Taranaki District Council, New Plymouth District Council, Stratford District Council. Tonkin & Taylor Ltd. 82 p. https://www.southtaranaki.com/repository/libraries/id:27mlbegko1cxbyf94es5/hierarchy/Documents/Plans%2C%20strategies%20and%20reports/Environment%20and%20Sustainability/Tonkin%20and%20Taylor%20Organics%20Feasibility%20Report%20%28FINAL%29%20-%202022%2006%2017.pdf (accessed 28/11/2023)

UMR 2021. General public attitudes to composting and compostable packaging – survey report. Prepared for Ministry for the Environment. 45 p.

https://environment.govt.nz/assets/publications/General-public-attitudes-to-composting-and-home-compostable-packaging-Survey-report.pdf (accessed 27/11/23)

USCC 2022. Model Compost Rule Template. Raleigh, US Composting Council. 42 p. https://cdn.ymaws.com/www.compostingcouncil.org/resource/resmgr/documents/Model_Compost_Rule_Template_.pdf (accessed 27/11/23)

Weidner T, Graça J, Machado T, Yang A 2020. Comparison of local and centralized biowaste management strategies - A spatially-sensitive approach for the region of Porto. Waste Management 118: 552-562. https://doi.org/10.1016/j.wasman.2020.09.013

WRAP 2020. Information sheet: Promoting home composting. Banbury, Waste & Resources Action Programme. 9 p. https://wrap.org.uk/sites/default/files/2020-09/WRAP-Home%20composting%20guidance%20for%20local%20authorities_0.pdf (accessed 27/11/2023)

WRAP 2021. Household food waste collections guide: Section 3: How much food waste can be collected for recycling? Banbury, Waste & Resources Action Programme. 10 p. https://wrap.org.uk/resources/guide/household-food-waste-collections-guide/how-much-food-waste-collected-recycling (accessed 28/11/2023)

Yates S 2023. Research into barriers to use of food scraps collections. Prepared for the Ministry for the Environment. Auckland, Sunshine Yates Consulting. 60 p. https://environment.govt.nz/assets/publications/Waste/Research-into-barriers-to-use-of-food-scraps-collections.pdf (accessed 27/11/23)

Chapter 4

Literature Review: preventing and eliminating contamination of organic materials

Liam Prince
The Rubbish Trip

November 2023

This paper discusses the issue of contamination of organic materials destined for processing into valuable soil additives and fertiliser products (e.g. via composting, anaerobic digestion). After defining contamination and highlighting key problems and risks, including the impacts of contamination from a Te Ao Māori perspective, the document then identifies and discusses effective ways to prevent, reduce and manage contamination.

Contents of Chapter 4

Executive summary

This paper discusses the issue of contamination of organic materials destined for processing into valuable soil additives and fertiliser products (e.g. via composting, anaerobic digestion). After defining contamination and highlighting key problems and risks, including the impacts of contamination from a Te Ao Māori perspective, the document then identifies and discusses effective ways to prevent, reduce and manage contamination.

What contamination is and why it's a problem

Contamination occurs when compostable organic materials (food scraps, garden waste, biosolids etc.) contain unwanted and potentially harmful substances ('contaminants'). Unmanaged contamination poses a threat both to the value and safety of the products of organics processing (e.g. compost, worm castings, digestate, soil amendments etc.) and thus threatens the wellbeing of the environments and communities in which they are used. Contamination can also threaten the viability of organics processing facilities by adding unnecessary costs and inefficiencies to the process, and by affecting the marketability of outputs like compost. At a high level, contamination is a key challenge to the viability of a safe, regenerative circular (bio)economy.

Contamination covers many different substances and materials, broadly divided into physical, chemical and biological contaminants. While some types of contaminants are well-known (e.g. plastics and weed seeds), others are less well understood – particularly invisible substances like chemicals. Common problematic contaminants and their sources include (but are not limited to):

- **Plastics** (physical) – largely from packaging being mistakenly placed in food and/or green waste collection containers. The concern with plastic contamination is as much aesthetic or cosmetic (i.e. compost containing visible plastics is not a good look) or practical (e.g. costs of removal and risk of damage to machinery) as it is about the environmental/health risks. Bio-based and compostable plastics are sometimes considered contaminants because they are difficult to process, may introduce other contaminants (e.g. chemical additives), and are often confused with non-compostable plastics.
- **Microplastics** (physical) – can be present in food scraps and animal by-products (especially seafood), and can be produced by plastic products, including compostable packaging. Can also be inadvertently introduced by mechanical pre-processing equipment like shredders, grinders and de-packagers, or from larger plastic items fragmenting during processing. The ecosystem and human health implications of microplastic contamination are not well understood, but emerging research gives cause for concern.
- **Persistent herbicides** (chemical) – includes products like clopyralid which are commonly used on recreational grass/turf. These do not break down easily and can severely harm or kill certain crops grown in composts contaminated with these herbicides.
- **PFAS** (chemical) – a family of chemicals used in a wide variety of products. Biosolids/sewage sludge and food packaging (including compostable packaging) are thought to be key sources of PFAS contamination in organics processing. PFAS are very resistant to degradation (they are known as 'forever chemicals', and a type of persistent organic pollutant or 'POP') and can accumulate in the environment in ever-increasing concentrations over time. PFAS can be taken up by plants and are known to be toxic to humans and animals.

There are many other contaminants of concern, including heavy metals, various other POPs and antibiotic resistant genes. New contaminants, especially chemicals, are emerging all the time.

A Te Ao Māori perspective on contamination extends beyond the immediately evident aspects of the physical, chemical, and biological contaminants discussed. This takes into consideration the:

- **Contamination of *kai atua*** and the role of food in Māori culture as a sanctifier.
- **Contamination of *whakapapa*** through the ingestion of endocrine-disrupting chemicals and the impacts on physiology, well-being and tribal progeny.
- **Contamination of *wairuatanga*** as the dominant social paradigm responsible for the creation of waste largely fails to recognise Māori spirituality and veneration of eco-centric atua Māori.
- **Contamination of *māramatanga*** due to impacts on intergenerational horticultural traditions and potential loss of local insights and wisdom associated with mahinga kai.
- **Contamination of *mana*** brought about by waste colonialism and food insecurity as a perpetuation of neo-colonial oppression of Māori.

Aotearoa New Zealand's move toward a circular (bio)economy must include a safe, high-value and regenerative circular organics system. This will involve a collective and culturally sensitive effort to address contamination that is technically sound and science-based in balance with mātauranga Māori. This means that not only must everyone involved – producers (e.g. households, businesses, food manufacturers, farms), collectors, processors and end-users – be aware of the various points where contamination might occur, the relative risk and prevalence of different contaminants, and the types of materials/feedstocks that are commonly contaminated. This will enable the introduction and support of key policy interventions to prevent and reduce contamination from occurring. In addition, to be responsive to Te Ao Māori, any solution should be assessed against its ability to address the issues stated above. This will require collective effort and early engagement with local iwi and hapū to identify solutions, prioritise, and take collaborative action, ultimately moving toward a system which incorporates appropriate and contextualised international best practices alongside an ethos unique to Aotearoa that embodies Te Ao Māori principles.

While there have been some important actions to address specific sources of contamination in the Aotearoa New Zealand context, they do not signal an overall shift towards a comprehensive approach to preventing and reducing contamination that is required. Some bans and restrictions of problematic materials (e.g. hard-to-recycle plastics, persistent aminopyralid herbicides) and targeted interventions with trade waste generators have helped, but a coordinated approach that instigates more such interventions alongside regimes to measure and improve their effectiveness is needed. The default approach to managing contamination – screening feedstocks and testing compost – is highly inadequate on its own: not only does it unfairly burden processors with responsibility for something largely beyond their control but fails to address many of the wide-ranging issues contamination presents.

Preventing and managing contamination

Different contaminants require different approaches. For example, while many biological contaminants like weed seeds and pathogens can be easily managed by following good processing procedures that are comprehensively outlined in the NZ composting standard NZS4454:2005 (i.e. ensuring minimum temperatures and residence times are maintained), most physical and chemical contaminants require interventions consistent with the top of the waste hierarchy that remove them from the system altogether. While physical contaminants can be somewhat removed from the process at multiple points in the system (particularly screening/sorting organics at a facility before they are processed), the most safe and effective approach is to prevent contamination at source (at or before collection). In contrast, addressing chemical contaminants once they have already entered the system requires remediation efforts that may or may not be effective. Again, a preventative approach (e.g. bans and restrictions) in line with the waste hierarchy would be more effective, including where they are directly linked with physical contaminants (e.g. compostable packaging containing PFAS coating).

This document identifies numerous interventions used outside Aotearoa New Zealand that can help prevent and reduce contamination. While each type of intervention has its place and various pros and cons, they typically work best when combined to reinforce one another. Evidence shows approaches that place too much emphasis on one type of intervention or another often struggle to achieve or maintain low contamination levels.

The range of interventions identified in this document can be divided into two broad categories:

- **Regulations** – legal restrictions that are pragmatic, monitorable and enforceable which can attract penalties (e.g. fines) if not followed, such as:
    - *mandatory source-separation* – requiring specific materials (e.g. food scraps) to be sorted and collected separately to other waste/materials.
    - *feedstock restrictions* – prohibiting certain materials from being collected (e.g. grass clippings, compostable packaging).
    - *product bans/phase outs/*controls – banning or restricting particular products or chemicals that frequently contaminate organic materials (e.g. produce stickers) from sale or use.
    - *maximum contamination limits on collected loads* – specifying a percentage limit (e.g. 1%) which contamination cannot exceed.
    - *compost/digestate standards and use restrictions* – requiring composts/digestates to meet certain standards on contamination concentrations, and restricting their use to certain low-risk applications (e.g. landfill cover) if concentrations are exceeded.

- **Contamination management plans** – contamination is a preexisting and complex issue with an array of potential risks and harms, so comprehensive, long-term, multi-stakeholder plans for preventing and managing contamination are needed alongside regulation. Features of such plans include:

    - A broad set of education/communication materials and tactics developed specifically for location and demographics.
    - Empowering collectors to address contamination at source by labelling contaminated bins/containers, not collecting them and providing feedback cards.
    - Addressing severe contamination swifty and precisely (rather than broadly).
    - Collection design features to minimise contamination (e.g. bin placements, container type, collection frequency, whether or not to use compostable bin liners).
    - Ensuring collectors and processors have clear provisions and expectations around contamination management in their contracts.
    - Regular monitoring and evaluation/auditing.
    - Facilitating stakeholder relationships.

1 Part 1: Framing the problem

1.1 Defining and understanding contamination

Contamination of organic materials can come in many forms. It is critical first to understand which substances can be considered contaminants, what their properties are, where they come from, how they find their way into organics feedstocks, how much of a risk they pose, and what problems they cause, before they can be managed with the most effective methods and appropriate level of urgency.[29]

Addressing contamination is essential to the viability of a safe, regenerative circular (bio)economy. The literature on circular economy (CE), bioeconomy (BE), and circular bioeconomy (CBE), and the adoption of these concepts in practice and policy both in Aotearoa New Zealand and internationally, have grown dramatically in recent years. In Aotearoa New Zealand, key government policy documents prominently use language around circularity and the bioeconomy, such as the first Emissions Reduction Plan (Ministry for the Environment 2022b), which has committed to the development of a circular economy and bioeconomy strategy, and Te Rautaki Para | Waste Strategy (Ministry for the Environment 2023) (also see Chapter 1 – Introduction from page 16 of this report). While this does not canvass this vast and growing body of literature, these concepts provide an important framework for both understanding and addressing contamination.

This section 1.1 provides an overview of various types and sources of contamination of organic materials, and outlines risk levels

Compostable packaging?

As the innovation and prevalence of compostable packaging has grown in recent years, so has concern and scrutiny of the implications for organics processing and their outputs. In Aotearoa, entities like The Ministry for the Environment (2022a), WasteMINZ (2022), The Packaging Forum (2021), and the Parliamentary Commissioner for the Environment (2018), among others, have released commentary, guidelines and recommendations on compostable packaging that outline a range of contamination-related issues (e.g. the need to better regulate labelling and certification standards to avoid consumer confusion, and compostability certifications allowing for non-biodegradable components up to 5% of total mass), while also acknowledging that compostable packaging has important use-cases, particularly by increasing the diversion/capture of organic materials from landfill to processors.

In some situations, and depending on its material composition (e.g. the presence of chemical additives), compostable packaging may itself be considered a contaminant. Not only can it introduce chemical contaminants to feedstocks and outputs, but it can complicate the composting or digestion process in several ways. For example, some processors may not achieve the conditions to adequately decompose these products, which can leave visible residues in the finished product. Even processors that are adequately equipped, compostable packaging can slow down the process due to inconsistent rates of degradation, can inhibit methane production in anaerobic digestion facilities, and may raise or lower greenhouse gas emissions from composting. Because of consumer confusion, accepting compostables can also lead to higher contamination rates from non-compostable packaging (ICF Incorporated 2021a, pp. 9, 35-36). Some of these effects are further detailed in the following section, noting that this chapter focuses on the potential contamination implications of compostable packaging. A comprehensive discussion of the pros, cons, trade-offs, and best practice policy on compostables is out of scope. For more, see the University of Auckland report on the impacts of compostable products on soil (Padhye et al. 2023).

[29] The Ministry for the Environment also commissioned a 2023 study into organics contaminants in Aotearoa New Zealand (‘Options for Contaminants in Organic Waste’, ref. 1224-01-RFP), the findings of which provide useful information and perspectives on the issue and should be read in conjunction with this report.

associated with different contaminants and contaminated feedstocks. The following section 1.2 discusses the various problems and impacts caused by contamination, including impacts arising from a Te Ao Māori perspective.

1.1.1 Types of contamination

The Australian Government publication *Food and Garden Organics: Best Practice Collection Manual* (Hyder 2012, p.94) divides contaminants into three broad categories: **physical**, **chemical** and **biological** contaminants. While some overlap between these categories exists, particularly between physical and chemical contaminants (Hyder 2012, pp. 48 & 94; Thakali et al. 2022; Wilkinson et al. 2019, p. 83), there are some significant differences between them that require distinct approaches to mitigating specific contaminants (some general measures also apply).

Plastics, particularly packaging (ICF Incorporated 2021a, pp. 1-4), are the most common and problematic form of **physical contaminants**, though other common forms are glass, metals and rocks. Plastics can be introduced to organics collections both intentionally (e.g. due to confusion over compostability) or inadvertently (e.g. microplastics), and tend to contaminate food waste streams in larger quantities than garden organics (p. 7) – although combined FOGO collections have also been identified as attracting larger amounts of contamination (Hyder 2012, p. 48). Physical contaminants can be managed at multiple stages of the value chain, from pre-collection through to processing and preparing product for market.

Chemical contaminants include a diverse range of substances derived from an equally diverse set of sources. The chemicals of concern identified in the literature include heavy metals, persistent herbicides (particularly clopyralid, aminopyralid, picloram, and aminocyclopyrachlor), and persistent organic pollutants (POPs), most notably PFAS (and other organo-halogenated substances), but also PCBs and PAHs (Hyder 2012, p. 94; ICF Incorporated 2021b; Thakali et al. 2022; Wilkinson et al. 2019). The risks and effects of many such substances are unknown; some have only been widely recognised as chemicals of concern very recently (e.g. PFAS) while others have been understood for longer (e.g. PAHs). Chemical contaminants are best controlled via understanding and managing/limiting feedstocks and sources, rather than at the processor level.

Biological contaminants typically include well-known problems such as microbial pathogens and weed seeds, but also include emerging contaminants such as antibiotic resistant genes (ARGs) (Thakali et al. 2022). Pathogens and weed seeds can typically be adequately managed by following best practice processes (e.g. following the Composting Standard NZS4454:2005) or by managing feedstocks (although this can be more challenging in onsite and small-scale systems such as home composting), whereas ARGs are more pervasive and difficult to manage through conventional means.

1.1.2 Risk

According to the Australian Government's *Food and Garden Organics: Best Practice Collection* Manual, contamination carries the highest level of risk of all possible risks to implementing successful organics collections (Hyder 2012, p. 55). However, there are varying levels of risk attached to the wide variety of potential sources and substances that cause contamination. Some contaminants or commonly contaminated feedstocks may present a serious level of risk to the quality and safety of organics processing products/outputs, and it is critical that these are known to manage them adequately. Other contaminants may present a low level of risk and thus do not require any significant or specialised management.

One useful initial filter to help determine risk of contamination is by categorising feedstocks. In a comprehensive and detailed analysis of contamination in Queensland's composting sector, Wilkinson et al. (2019) categorise and analyse a wide range of composting feedstocks for their contamination potential. They provide extensive commentary, data and analysis on the potential sources and effects of contamination, and in Chapter 6 provide a risk assessment for various feedstocks. The table on feedstock contamination risk levels (see *Table 1*) includes some inputs labelled as 'very high risk' not normally associated with composting, such as paint wash, filter/ion exchange resin backwash waters and other water-based effluents (dyes, inks & paints). However, they also list some more common feedstocks as carrying 'high risk', like paper processing waste (mulch, pulp effluent and sludge), soils, plaster board, sewage treatment waste (sludge, biosolids, septic wastes), and organics extracted from MSW. Many common composting inputs (e.g. food organics, green waste) are labelled low risk.

Although the authors cite a lack of data on the exact composition and sources of certain feedstocks (which has raised the risk rating of certain feedstocks), the study's risk assessment (Chapter 6) provides a useful starting point to guide further analysis of feedstocks in more specific circumstances, particularly by highlighting which feedstocks raise cause for concern. The report recommends a precautionary approach to assessing contamination risk, especially where data is lacking, and recommends the Queensland Department of Environment and Science develops a database of "feedstock compositional analyses" to better understand and quantify the issues and set guidelines and policy on contamination (pp. 23-24). It is important to note that the below issues and risk levels are associated with the feedstocks in Queensland's composting sector, and an exploration into the specifics of Aotearoa New Zealand's sector is needed. This would include considering climactic differences, and unique factors/experiences with feedstocks in meat processing (e.g. use of boluses), oil and gas drilling (muds), treated timber, and biosolids.

Low risk	Medium risk	High risk	Very high risk
Food Organics	Tub ground mulch	Soil	Paint Wash
Vegetable waste	Wood waste (excluding chemically treated timber) including pallets, offcuts, boards, stumps and logs	Amorphous silica sludge	Sullage waste (greywater)
Cypress chip	Food processing treatment tank or treatment pit liquids, solids or sludges	Mud and Dirt Waste	Bilge waters
Forest mulch	Sawmill residues (inc. sawdust, bark, wood chip, shavings etc.)	Quarantine waste treated by an AQIS approved facility	Dye Waste (water based)
Green waste	Brine Water	Abrasive blasting sand (excluding heavy metal contaminated sands)	Water based inks
Pine bark	Calcium Water	Paper mulch	Forecourt Water
Wood chip	Fertiliser water and fertiliser washings	Paper pulp effluent	Treatment tank sludges and residues
Beer	Acid Sulphate Sludge	Paper sludge dewatered	Hide curing effluent
Grain Waste	Wood molasses	Plaster board	Filter cake and presses
Gypsum	Waterbased glue	GPT Waste	Water based paints
Lime	Coolant Waste	Mill mud	Filter/ion exchange resin backwash waters
Sand	Polymer Water	Soil treated by indirect thermal desorption	Waste Water
Cane residues	Soapy water	Bauxite sludge	Leachate Waste
Crusher dust	Ground Water	Water blasting wash waters	Process Fluid
Lime Slurry	Low level organically contaminated stormwaters or groundwaters	Carbon Pellets	Effluent Waste
Molasses Waste	Ash	Waterbased Lacquer Waste	
Soft Drink Waste	Coal ash	Latex Washing	
Vegetable oil wastes and starches	Fly ash	Boiler blow down water	
Yeast Waste	Drilling Mud / Slurry (Coal Seam Gas)	Car Wash Mud & Sludge	
Cement Slurry	Dewatered fertiliser sludge	Oily Water	
Animal manures, including livestock manure	Bentonite	Stormwater Waste	
Animal processing waste	Compostable PLA plastics	Vehicle wash down waters	
Animal Waste, including egg waste and milk waste	Natural textiles	Wash Bay Water	
Paunch material	Muddy Water	Carpet cleaning wash waters	
Abattoir waste	Total Petroleum Hydrocarbon Water	Foundry sands	
Tallow Waste	Treated timber waste	Biosolids	
Brewery effluent		Nightsoil	
Food processing effluent and solids		Sewage sludge	
Grease trap - treated grease trap waters and dewatered grease trap sludge		Sewage treatment tank or treatment pit liquids, solids or sludges	
Grease trap waste		Septic wastes	
Starch Water Waste			

Low risk	Medium risk	High risk	Very high risk
Sugar and sugar solutions Worm castings suitable for unrestricted use Mushroom compost (substrate) Pot ash Ammonium Nitrate		Activated sludge and lime sludge from wastewater treatment plants Organics extracted from mixed household waste / MSW	

Table 3: 'Summary of feedstock contaminant risk ratings' (Wilkinson et al. 2019, pp. 183-184)

Another means of determining risk is by source, or the likelihood of encountering contamination based on where the material/feedstock has come from. This has the benefit of considering feedstocks in context, rather than as isolated streams, to determine the potential for contamination. The same feedstock (e.g. food waste) coming from different sources (e.g. households, retail, food processing, institutions) may be more or less likely to be contaminated, and may contain different types of contaminants. Table 2 summarises this likelihood of contamination (and the contaminants expected) from various food waste sources. Note that 'green bins or source separated organics' pose the second highest contamination risk behind only MSW:

Levels of Contamination

Each food waste stream has its own set of obstacles, some more challenging than others.

Food Waste Source	Examples	Contamination Description	Contamination level
Food & beverage manufacturing	Snacks, baked goods, meat/poultry processing, dairy goods –cheese, ice cream, yogurt.	Attention given to CIP chemicals (clean-in-place) for disinfection purposes as those can sometime be toxic to digestion process.	1
Pre-consumer	College or hospital cafeteria prep, restaurant prep, grocery delis, etc.	Gloves, packaging, utensils	2
Post-consumer	Cafeteria and restaurant waste bins	Utensils, paper goods, some glass/plastic/cans	3
Green bins or source separated organics (SSO)	Municipal green collection programs	Packaging/wrappers – plastics/paper, some glass. Miscellaneous 'garbage'	4
Municpal solid waste (MSW)	Most cities in the US	Anything and everything	5

Table 4: Food Waste Source Sorted by Contamination Level (McKiernan 2015)

These two types of risk analysis (by contamination source and feedstock type) could be useful to undertake in combination by providing a two-step filtering process. This is to some extent already the case for the analysis in Wilkinson et al. (2019) which, for example, differentiates food waste from various sources and allocates risk accordingly. Additionally, risk assessment frameworks of organics processing outputs such as that proposed by Longhurst et al. (2019) can help determine the level and type of risk based on the impact of using contaminated composts/digestates.

1.2 Why contamination is a problem

Understanding the sources and types of contamination must be coupled with an understanding of the consequences of contamination if not prevented or managed appropriately. This section describes how contamination can pose a major threat to safe and efficient organic materials management systems – and is a key issue to be resolved in the transition to a safe and regenerative circular (bio)economy – in several ways: by reducing the efficiency and increasing costs of processing organics, affecting the quality and marketability of products (e.g. compost and digestate), negatively impacting food-growing systems where end-products are applied, having potentially dangerous and irreversible effects on the natural environment (Hyder 2012, p. 48), and compromising the principles of *kai atua, whakapapa, wairuatanga, māramatanga, mana,* and other aspects of Te Ao Māori.

In seeking to integrate Te Ao Māori perspectives on contaminants into this literature review, it is crucial to understand that these perspectives stem from overarching Te Ao Māori concepts. Chapter 1 – "Whakapapa-centred organics processing to transform local economies and communities across Waikato" (see p.26), uses the general Atua-Whenua-Tangata approach to guide our investigation of organics processing, and its potential to transform local economies within Waikato, within a culturally appropriate manner. This preliminary scoping was foundational for this subsequent dive into Te Ao Māori perspectives of contaminants that impact organics processing.

As detailed in Chapter 1, a subset of Te Ao Māori concepts is presented within the Hua Parakore framework, that are specifically focussed on the culturally appropriate practices of growing organic food.[30] This subset of Te Ao Māori concepts, used as principles for the framework, has been used to refine further our approach to understanding the important impacts of contaminants.

1.2.1 Impact on organics processing businesses and markets

Contamination is a significant threat to the viability of businesses in the organics processing sector, regardless of how well processors manage contamination. Mitigation costs can be considerable and are not always fully effective, processing can be slowed and compromised by the presence of contaminants, and contaminated products have little value, use or marketability.

Processors are at the heart of a potential area of conflict in the transition to a circular (bio)economy: that is, the extent to which organics processing helps to maintain the regenerative capacity of natural cycles and ecosystems by producing clean, high-quality, uncontaminated products, versus to what extent organics processing is seen as a waste treatment/management tool. This conflict can only be resolved by approaching the issue from beyond the organics processing sector; currently, organics processors are unfairly impacted by and burdened with managing contamination, and yet do not create the issue, emphasising the need for upstream interventions based on polluter pays/ extended producer responsibility principles.

1.2.1.1 Processing

While a range of manual and mechanical sorting and screening technologies have been developed to remove physical contaminants from feedstocks, their effectiveness is limited. These technologies including picking stations, airlift separators, star screens, air and floatation conveyor separators, sieves, and depackagers. The U.S. EPA report, *Emerging Issues in Food Waste Management: Plastic*

---

[30] Hua Parakore is a Māori framework for growing organic food created by the Te Waka Kai Ora National Māori Organics Group through a research project that involved Māori organic growers, traditional healers, and community researchers from New Zealand (Hutchings et al. 2012). It is a system that verifies and validates the production of pure food (Te Waka Kai Ora 2023). The six key principles are Whakapapa, Wairuatanga, Māramatanga, Mauri, Mana, and Te Ao Tūroa.

Contamination, concluded that while these forms of pre-screening can help reduce contamination in feedstocks prior to processing, they:

> **"can be costly and are not fully effective. Plastic material, including microplastic, has been repeatedly observed in finished products. Further, it is unclear to what extent technologies (e.g., shredders, grinders and de-packagers) may inadvertently introduce microplastics or nanoplastics into the end products by breaking down larger pieces of plastics" (ICF Incorporated 2021a, p. ii. See also pp. 11-15).**

The ineffectiveness of screening technologies can result in processors sending substantial amounts of contaminated feedstocks to landfill, as has happened with some anaerobic digestion facilities in Canada and Spain (p. 19).

Also, because screening techniques/technologies are primarily designed to remove physical contaminants, they do not specifically address chemical and biological contamination. However, Thakali et al. (2022, p. 10) identify effective pre-screening to remove physical contaminants as potentially important to reduce the risks of PFAS contamination. Thus, while pre-screening at processing facilities can help, they create significant costs to processing operations for an approach that is not fully effective at removing contamination.

Contamination can also impact processing by inhibiting/altering normal biological functions and lengthening processing timeframes. Particularly physical contaminants like plastic – including some compostable plastics like PLA – can reduce methane production in anaerobic digestion facilities by 10% or more (ICF Incorporated 2021a, p. 10; 36). In composting, recent research found that microplastics can cause greenhouse gas and ammonia emissions to increase or decrease depending on the plastics' types and characteristics (p. 9). Some compostable plastics (but potentially also woody products such as bamboo cutlery), especially thicker non-film products, take significantly longer to break down compared to typical feedstocks (e.g. food and green waste), lengthening the time it takes to complete the composting process (p. 35). These effects can significantly impact the viability of processors' businesses by reducing the revenue able to be generated.

1.2.1.2 Products and their use

Contamination triggers negative perceptions (whether justified or not) of organics processing products. Such perceptions, whether arising from first-hand experience or from stories about the impacts of using contaminated products (e.g. soils full of plastics or crop losses), affect the marketability of these products, lowering their value, and have led to restrictions on the applications for which contaminated products can be used.

Plastics are seen as "the biggest challenge to end-product quality due to its volume and variability" (p. 15). While the undesirable aesthetic qualities of visible plastic contamination may shape negative perceptions (e.g. Image 1), microplastics too small to see with the naked eye have frequently been found in lab studies of composts and digestates worldwide, despite limited data (more on their impact below). Some microplastics are generated by the process itself due to the partial but incomplete degradation of larger plastics (pp. 15-19). See more commentary on the plastics issue in section 1.2.3.1.

Image 1: Plastic contamination at a NZ composting facility

While plastics are a major problem, growing knowledge of emerging chemicals contaminants (such as PFAS) is also a threat to the viability of organics products. A 2019 survey of US composting industry stakeholders found contaminants to be the second most important trend affect the industry, with PFAS contamination alone in the top 10 (ICF Incorporated 2021b, p.1). Regardless of whether or not the full implications of chemical contamination are properly understood, whether a product is contaminated or not, or even how diligent an individual processor may be in preventing and removing contaminants from their products, impacts have occurred across the whole sector:

> **"Regardless of whether PFAS are actually present at levels of concern in composts and digestates made from food waste, concerns about contamination can, and have, affected the marketability and value of these products, in addition to decisions and policies applicable to food waste collection, management, processing, and consequently, the reduction of food waste" (p. 66).**

In one US example, although not specifically related to food waste, a composting facility that processed paper mill residuals as a feedstock was shut down by the local state after PFAS was detected in water at the facility, also leading to the paper mill being required to landfill this material instead (p. 53).

These issues reflect an unfair burden of responsibility placed on processors to deal with contamination and produce safe outputs. This reflects one aspect of the impact contamination has on *mana* through processes such as 'waste colonialism', which is detailed in section 1.2.3.5. Isenhour et al. (2022) explain that despite feedstock contamination being largely beyond the control of processors, they are the ones burdened with mitigation costs (screening, testing, grow-outs, training, education and relationship building), while little to no responsibility is placed on companies and consumers who create or use the products that cause the contamination in the first place. Furthermore, the "voluntary, slow, and extremely expensive" system for contaminant testing and mitigation in the US (likely similar in Aotearoa) creates an unequal playing field where those who do take the initiative receive a competitive disadvantage (p. 348). As the U.S. EPA plastics contamination report points out:

> **"Maintaining product quality is key to maintaining market demand for end products, and processors must balance the costs of removing contamination... with maintaining competitiveness" (ICF Incorporated 2021a, p. 15).**

While mandatory testing and standards could help level the playing field among processors (and is mentioned as an important tool to mitigate contamination in Part 2 of this report), it still places the onus on the processing end of the organics value chain. Alongside a wider range of interventions discussed in Part 2, tools that adopt the polluter pays principle, such as product stewardship/EPR schemes and much tighter regulations on the chemical industry, could help to share the burden more equitably.

1.2.2 Human, environmental and cultural health impacts of contamination

The real-world harms of contamination on soil, plant, animal, human and ecological health are at the heart of why contamination is a problem. The direct threat that contamination may pose to the health of living biological systems (which humans and other organisms rely on for survival) is also arguably what underpins the concerns that impact commercial viability and markets for organics processing. These harms primarily revolve around the safety of organics processing outputs/products (compost, digestate, vermicast and other soil amendments), and the downstream impacts of their use. These downstream impacts are particularly crucial with respect to the centrality of kai (food) in Te Ao Māori, which justifies anchoring such an analysis with the principles of the Hua Parakore framework.

The following sections outline the impacts of contamination from a Te Ao Māori perspective. Part 1 of this report concludes with a summary of the current state of knowledge of the causes of harm from contamination, and argues that the issue of contamination of organics materials and products must also be seen as a symptom of the much larger, much more threatening prospect that we have exceeded the planet's capacity to recover from chemical and plastic pollution.

1.2.2.1 The impacts of contamination through the lens of Kai Atua

Understanding the role of food in relation to the contamination of organic waste is the starting point to understanding Te Ao Māori perspectives on contaminants in the collection of food scraps and processing of organic waste.

Food was, and remains, an invaluable sanctifier for Māori; restoring spiritual and physical balance, allowing for protocols of manaakitanga, and facilitating rituals of whakanoa[31] (Viriaere & Miller 2018). The significance of traditional kai in Māori culture is also mirrored in the histories and revivals of other indigenous cultures' practices. This reflects the central role that the process of kai plays in Māori culture (Pehi et al. 2009).

An example of the culturally significant use of kai can be observed in the pōwhiri process. When entering a marae, visitors enter a state of tapu, marked by the karanga, whaikōrero, and karakia recited on the marae ātea. Once the formal processes have been completed, kai plays a critical role in the practice of whakanoa, transitioning visitors back into a state of noa on the marae.

The National Māori Organics Group, Te Waka Kaiora, refer to pure food as *kai atua. Kai atua* is defined as pure food that is free of chemical pesticides, fertilisers and GMOs, where it is produced in ways that accord with Māori values, to support healthy food-secure futures for whānau (Te Waka Kai Ora 2010). Kai atua are creations of atua Māori, passed on by ancestors, and down to future generations as *taonga tuku iho*[32]. Several indigenous species of kai are held highly in this regard, as well as the other supporting species that are critical to their well-being and fertility.

Subsequently, food production was an activity that held a level of sanctity from planting to harvest (Tawhai 2013). Viriaere and Miller (2018) state that "for Māori, gardening is underpinned by spiritual connections to their gods and the metaphysical and holistic understandings of how Māori interpret their environment (Marsden & Henare 1992)." Accordingly, the first principle of producing kai atua is having healthy soil (Hutchings et al. 2018).

Thus the presence of contaminants and heavy metals within the food cycle, through the application of physical, chemical and biological contaminants is detrimental to the sanctity of *kai atua* and should be recognised first and foremost as the contamination of a spiritual, physiological and cultural sanctifier within Te Ao Māori (Hutchings et al. 2018).

1.2.2.2 The impacts of contamination through the lens of Whakapapa

The contamination of *kai atua* segues into the contamination of *whakapapa.* Whakapapa is a widely covered topic and permeates through scholarly discourse and traditional schools of learning (Barlow & Wineti 1991; Marsden 2003; Mead 2016).

The quintessential manifestation of whakapapa contamination lies in the degradation of ecosystems. Within Te Ao Māori, an inherent ontological connection binds people to their landscapes.

[31] *Whakanoa* is the process of removing tapu. There are many rituals and processes to remove tapu, usually involving kai or water, and always involving kōrero. https://www.hapai.co.nz/content/whakanoa-interview-stephanie-erick

[32] *Taonga tuku iho* are treasures handed down from Māori ancestors

Mountains, rivers, oceans, flora and fauna are personified as ancestral beings, kaitiaki and atua Māori that manifest within Te Taiao. This sacred connection brings with it the responsibility to nurture and reciprocate the sustenance offered by these ancestors and atua which Māori livelihoods depended upon. The contamination of these ecosystems, therefore, represents an violation of this significant connection.

Moreover, contamination poses a significant threat to the anthropocentric element of whakapapa – genealogy (tātai whakapapa). The presence of physical and chemical contaminants within our food stream is an issue of growing concern and contribution to the disruption of physiological well-being (Mukherjee et al. 2021).

The effects of endocrine-disrupting chemicals (EDCs) on human health have been detailed by numerous organisations including the Endocrine Society (Flaws et al. 2020). In marine ecosystems, microplastics act as carriers for other harmful chemicals that are present in the environment. These chemicals, such as pesticides and heavy metals, can attach to the surface of microplastics and are transported into the body through ingestion.

Tina Ngata stated in an interview conducted by CLEAR (Ngata & Liboiron 2020):

> **"Plastic is a disruptor of whakapapa – which is huge in Te Ao Māori (the Māori world). As an endocrine disruptor, it has the power to affect hormones and reproductive cycles. As the core binding concept of our world, starting the conversation from there is much more meaningful".**

This is a direct threat to the genealogical aspect of whakapapa and the well-being of tribal progeny. The detrimental role of EDCs on physiology can therefore be considered as the contamination of *whakapapa*.

A study conducted by Scopetani et al. (2022) regarding endocrine-disrupting chemicals concluded that "compost application is a source of plastic pollution into agricultural fields, and that plastic might transfer hazardous contaminants to soil". In addition, plastics usage (and inadequate waste management) in the agriculture sector has been recognised as an increasing risk to contamination of food-production soils and thus food itself both globally (FAO 2023) and in Aotearoa (Scott 2016; Matthews 2014), highlighting the need for greater producer responsibility/product stewardship mechanisms to prevent these impacts.

Therefore, the importance of eliminating the presence of physical and chemical contaminants from the organics processing cycle should be framed as the mitigation of the pertinent risk posed to whakapapa genealogies.

1.2.2.3 The impacts of contamination through the lens of Wairuatanga

The contamination of whakapapa and kai atua leads to the wider discussion of spiritual contamination. Wairuatanga, as defined within the Hua Parakore framework, is the spiritual health and peace of the land, the food and the people (Hutchings et al. 2012), involving ritual incantation, and the reverence and veneration of atua Māori.

Kennedy et al. (2020) address the dominant social paradigm in Aotearoa, stating Milbrath's (1984, p. 7) definition: "the metaphysical, beliefs, institutions, habits…that collectively provide social lenses through which individuals and groups interpret their social world." The dominant social paradigm within Aotearoa is based on the ideas of economic growth and emphasises the principles of laissez-faire economics and individual property rights, which are rooted in the construct of human-domination-over-nature (Kennedy et al. 2020).

This construct was illustrated by Easton (2020, p. 81) through the concept of a 'quarrying economy', also referred to as a 'colony of exploitation'.

As detailed in "Not in Narrow Seas: The Economic History of Aotearoa New Zealand" (p. 81, Victoria University Press), this approach is synonymous with the extensive extraction and exploitation of finite resources. It is also noteworthy that while initial Māori settlements exhibited similar patterns, albeit less intensively, there has been a shift towards principles of kaitiakitanga (guardianship) and sustainability, indicating an evolution in environmental stewardship.

As such, the tenet of human-dominion-over-nature has been historically manipulated to serve the wider phenomenon of colonialism and capitalism, as means to justify the historic for-profit explotation of ecosystems (Hickle, 2020).

The importance of the spiritual connection between people and the land, and places as other; specifically from the eco-centric, and indigenous worldview of Māori that acknowledges the mauri[33] of all livings things, and the kinship between people and the natural world (Marsden & Henare, 1992).

This highlights the clash between Māori eco-centric beliefs and the anthropocentric views of dualism and materialism, which have been historically manipulated by advocates of capitalism and colonialism. This serves to void the divinity of the natural world and rationalise the exploitation of Papatūānuku (Mother Earth) and Ranginui (Sky Father).

This contamination of *wairuatanga* is the failure to recognise the spiritual impacts on these atua Māori, such as Hineahuone, Papatūānuku and Rongomatāne, and the cross-contamination of things *tapu* and *noa* (Marsden, 1992; Sachdev, 1989). This spiritual contamination leads to the inability to comprehend the spiritual importance of cultural practices such as incantation and kaupapa Māori approaches to well-being in relation to the use of organic materials derived from these natural realms.

1.2.2.4 The impacts of Contamination through the lens of Māramatanga

The principle of māramatanga is the insight and enlightenment gained through mahinga kai. Mahinga kai[34] is important to the cultural identity of Māori because it connects individuals to each other and to their environment through traditional practices that have spanned across generations. In addition to providing physical sustenance, mahinga kai is a spiritual connection to atua (Panelli & Tipa 2009).

Mahinga kai is associated with Māori and Polynesian horticultural histories. Māori brought various crops from Polynesia, such as kūmara (sweet potato), taro, hue, and ti pore. These cultivar species acknowledged as *taonga tuku iho*, continue to be passed down through generations, both as a means of sustenance and a symbolic representation of the survival and wellbeing of Māori

---

[33] *Mauri* is the principal essence of life held by all living things (Morgan, 2006).

[34] *Mahinga kai* can mean 'to work the food'. This relates to not just the gathering of kai but also the ecosystems and habitats these species are found in. https://www.sciencelearn.org.nz/resources/3174-mahinga-kai

ancestors. Many introduced varieties of potato later came to feature in Māori horticulture (McAloon 2013), while certain iwi hold records of particular potato cultivars before European arrival (McFarlane 2007).

Today, the widespread use of compost, and other organic by-products from horticultural processes, as a soil amendment to maintain and improve soil fertility, coupled with the dominance of Māori horticultural traditions in growing food, make the cultural practice of *mahinga kai* susceptible to contaminants.

Although the salient health risks associated with vegetables grown in contaminated soils in the presence of heavy metals have been widely recognised (Zwolak et al. 2019), the cultural connotations of contamination are greater. The risks of contaminants entering the horticultural practices of *mahinga kai*, especially for smaller-scale marae and whānau operations, can potentially contribute to the hindrance or termination of those practices, and the consequent loss of insights, enlightenment, and transmission of indigenous wisdom through the collective practice of *mahinga kai.* This is the contamination of *māramatanga.*

1.2.2.5 The impacts of Contamination through the lens of Mana

The analysis of contamination through various Te Ao Māori concepts leads to an eventual discussion of self-determination, food sovereignty and waste colonialism.

Food sovereignty is a concept that prioritises the right of communities and individuals to have access to healthy, culturally appropriate, and sustainably produced food (Hutchings 2020). In a capitalist settler-colonial society, food sovereignty can be seen as a mechanism of self-determination and freedom because it allows marginalised communities to take control of their own food systems and reject the dominant capitalist food system that often exploits the natural world by extension themselves (Patel 2009).

In the article “ls Māori food sovereignty affected by adherence, or lack thereof, to Te Tiriti O Waitangi?”, Shirley (2013) makes the link between food sovereignty and rangatiratanga, as stated in Te Tiriti o Waitangi, as they both represent a form of sovereignty. Through the colonisation of Māori land and people, the food systems were also colonised.

Shirley concluded that:

> **”the disempowerment of Māori through their food system ties into a wider trend of Māori, and indeed indigenous people globally, being deliberately targeted and disadvantaged through various aspects of their lives”**

The contamination of organic materials and food cycles, and the associated impact on Māori horticultural practices, can be identified as contributing to the ongoing colonisation of the food system leading to food insecurity (McKerchar et al. 2015).

1.2.3 Known and emerging causes of harm

Scientific evidence of the harms caused by some contaminants are well understood, while others are less well or not at all understood nor subject to any form of control/regulation. Contaminants whose sources and/or effects are relatively well understood (e.g. heavy metals, PCBs, PAHs, pathogens, persistent herbicides) consequently have had more controls developed to eliminate them or mitigate their effects in organics processing. Such measures (listed in Part 2 of this report) include heavy metal and pathogen detection limits in composting standards, source separation, testing and restricting feedstocks that commonly contain contaminants (e.g. grass clippings, manure and hay containing persistent herbicides), and bans in the case of PCBs. Greater controls, coupled with a lack of recent data (ICF Incorporated, 2021b, pp.48-52) and low incidence of some of these well-known contaminants (Thakali et al. 2022, p. 9), has shifted the focus of concern and research toward emerging contaminants or novel entities.[35]

As might be expected, emerging contaminants such as PFAS and other POPs, relatively new biological substances like antibiotic-resistant genes (ARGs), micro/nanoplastics, and new synthetic chemicals (such as those used in plastics) lack data to sufficiently quantify the harms associated with these substances as well as accurately pinpoint the sources of such contaminants. The US EPA has stated:

> **"Given the very limited information identified in the literature, general conclusions cannot be made with confidence about human health and environmental risks associated with land application of compost or digestate produced from food waste. ...there is insufficient information to evaluate whether typical levels of contamination would pose unacceptable health or environmental risks when properly processed and managed" (ICF Incorporated, 2021b, p. 62).**

While more research is needed to understand the sources and impacts of emerging contaminants, existing data is concerning. The following subsections attempt to summarise state of knowledge for three emerging contaminants of concern: plastics, PFAS and ARGs.

1.2.3.1 Plastics

Plastic pollution is a major global issue, with intensified activity, research and scrutiny emerging from the negotiations for a global agreement to end plastic pollution (UNEP 2022a). This attention sits alongside a growing body of work highlighting and addressing the risks of plastic usage and pollution in specific sectors, including those highly relevant to this report such as the agricultural sector (e.g. see FAO 2021; FAO 2023; UNEP 2022b; EIA 2023). Such studies show that plastics used in agriculture can directly contaminate soils and food systems with microplastics and chemicals of concern, which can also then migrate to and disperse in other environments. These studies also indicate that organics recycling-derived products (compost, digestate etc) are only one (and likely not the worst) source of plastics contamination of food production soils.

While the effects of plastic pollution in the marine environment are better known, there is an increasing body of evidence on the harms of micro and nanoplastics on terrestrial ecosystems and organisms including fungi, bacteria, worms and others (e.g. de Souza Machado et al. 2017; Rillig & Lehmann 2020; Sarker et al. 2020; Khalid et al. 2020; Huerta Lwanga et al. 2016). The US EPA report collated evidence that found that plastic fragments can affect physical properties of soil such as texture, structure, colour, heat retention, drainage, bulk density and water availability; can impact plant performance, root biomass and area, water content, and leaf nitrogen content; and consequently, water cycling, plant-soil feedbacks and soil microbial diversity are all affected. In addition, not only are micro and nanoplastics known to have intrinsic ecotoxicological effects on a range of organisms, but plastic particles have also been shown to readily attract toxic substances to them via adsorption (ICF Incorporated 2021a, pp. 20-21). The impacts of microplastics on human health is even less well understood, but research in this area is growing.

[35] In the Planetary Boundaries framework, 'novel entities' are defined as "new substances, new forms of existing substances, and modified life forms that have the potential for unwanted geophysical and/or biological effects" (Steffen et al. 2015, p. 7).

In addition to the impacts of micro/nano-plastics, the chemical additives used in plastic products are of increasing concern, which present a direct threat to the Te Ao Māori principle of *whakapapa*. While there are well-known and documented health impacts of some commonly used chemical additives, such as endocrine-disrupting chemicals (EDCs) (Flaws et al. 2020), there are significant unknown quantities with plastics-related chemicals. The Scientists' Coalition for an Effective Global Plastics Treaty (et al. 2023a, p. 1) has summarised current knowledge of chemicals in plastics as follows:

> **"More than 13,000 chemicals are used in plastics, of which >3,200 are classified as hazardous. This means they are officially recognized to be toxic, persistent or have other concerning properties. …They can leach into our food, homes, and the environment, and adversely affect human health and the environment. …Only 128 of the >3,200 known hazardous plastic chemicals are regulated internationally, and at least 6,000 plastic chemicals have not been assessed for their safety.[2] Most polymers have undergone only a minimal safety assessment based on outdated criteria or are exempt from regulation altogether.[6] In addition, the effects of mixtures of chemicals present in plastics are not considered. This indicates a failure of current national and international regulations."**

1.2.3.2 PFAS

Over 3000 PFAS compounds exist (PDP 2018, p. 2), many of which are known to be persistent, bio-accumulative and toxic (p. 13). While the effects of PFAS in aquatic ecosystems (like plastics) are much better understood compared to terrestrial ecosystems and organisms, concerning levels of liver toxicity, developmental toxicity and immune system toxicity impacts have been observed, and many PFAS bioaccumulate more readily in terrestrial over aquatic organisms (p. 36-50). Given that some PFAS do not have a toxicological threshold value "below which toxic effects are not expected" (ICF Incorporated 2021b, p. 57), and that some PFAS compounds have been detected in high rates in organics processing feedstocks and products (e.g. pp. 4-34; Thakali et al. 2022, p. 9), there have been urgent calls to determine safe levels of PFAS concentrations, especially of newer types of PFAS (p. 10), in organics feedstocks and products. More information is also needed on "how they [PFAS] are introduced into the waste, their fate during treatment, and uptake from soils into plants and the rest of the food system in order to create policy that reduces the risk of contamination" (p. 9). This is a major challenge, however, as toxicity data on newer forms of PFAS are limited or non-existant, and how organisms get exposed to PFAS involves complex dynamics and variables that are extremely difficult to quantify (ICF Incorporated 2021b, p. 61).

1.2.3.3 ARGs

Antibiotic resistant genes are another key emerging contaminant of concern, which have been detected in food waste samples from multiple sources, sometimes in abundance (Zhao et al. 2022, p. 5; Thakali et al. 2022, p. 9). The widespread use of antibiotics in animal rearing have "caused the proliferation of many ARGs in the environment and contributed to a global increase in the incidence of infections by resistant organisms" (p. 2). This issue is seen as a key 21st century health risk by the World Health Organisation (Zhao et al. 2022, p. 1). As an emerging and complex area of concern in organics processing, it remains understudied; however, Zhao et al. (2022) found that food waste feedstocks and composts may be an important, underestimated source of antibiotic resistant genes and organisms, and that different methods of composting can either increase or reduce the abundance of ARGs in the final product.

1.2.3.4 Lack of data is a cause for concern – exceeding planetary boundaries

The lack of data and research quantifying the harms of organics contamination not only justifies the precautionary approach recommended across the literature, but our ignorance of the full magnitude of the problem is itself cause for alarm and demands immediate action. In January 2022, Persson et al. for the first time determined that the safe operating space for the 'novel entities' (e.g. synthetic chemicals and plastics) planetary boundary has been definitively exceeded (see Image 2). This claim is justified by the fact that emissions/releases of ecotoxicological novel entities into the environment are accelerating far faster than our ability to make adequate assessments of (let alone manage) the harms. In other words:

> **"We conclude that increasing trends of production and emissions of diverse novel entities that outstrip our efforts at safety assessment and monitoring are a transgression of the planetary boundary and that immediate actions are needed to return us to the safe operating space" (p. 1511).**

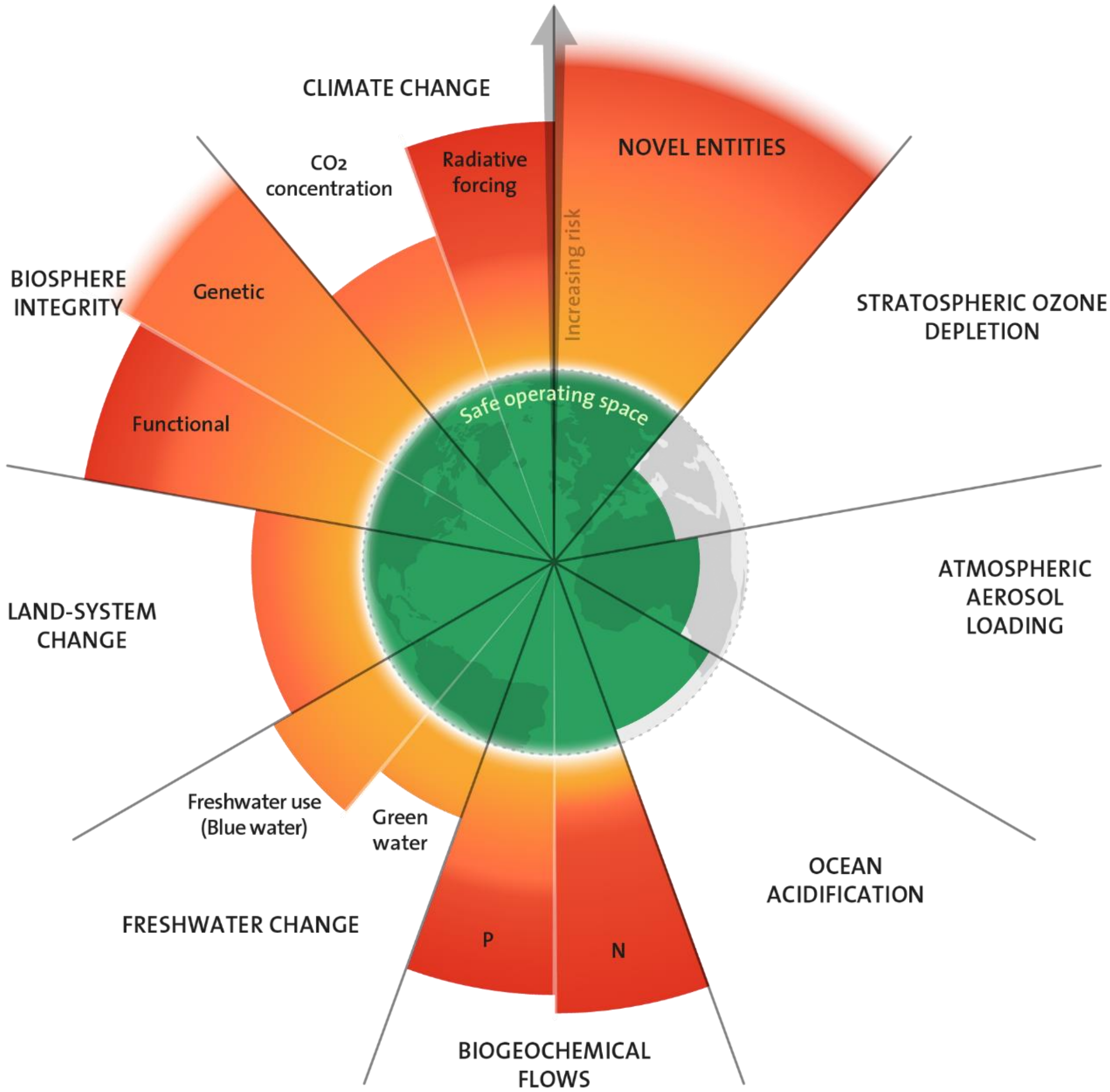


Image 2: 2023 update to the Planetary Boundaries Framework. Designed by Azote for Stockholm Resilience Centre, based on Richardson et al. 2023.

The authors identify evidence of the harmful effects of existing pollution in "ever-growing number of NEs [novel entities]... found in remote locations of the planet and the [increasing] number of grossly contaminated locations... despite remediation efforts", as well as "many distinct and partly interacting (e.g., synergistic) effects of NEs on Earth's physical and ecological systems", and call for immediate action "to reduce releases and emissions of NEs to the environment... **including a higher degree of circularity in product supply chains, material and product design, design for recycling, and safe and sustainable chemicals**" (p. 1517, emphasis added). A recent study that gained significant media attention (Cousins et al. 2022), in which unsafe levels of PFAS were found in rainwater, soils and surface water across the globe, is yet another example of the widespread contamination and exceedence of safe boundaries of natural planetary systems.

This view suggests that contamination of organics processing feedstocks and products is a small subset of environmental contamination at large, and that mitigation strategies must focus as much, if not more, upstream of the organics management system. As Isenhour et al. (2022) explain, there is a mismatch between the 'eco-modernist' thinking that underpins the idealistic separation of the biological and technical cycles of the circular economy, and the reality that these cycles are deeply entangled, which contamination (or "toxic trespass") represents:

> **"In the context of circular food systems, this failure to recognize the politics of entanglement has created a system which holds composters and digesters responsible for securing the line between biological and technical processes while the companies that produced trespassing chemicals accrue the benefts and, all too often, evade responsibility" (p. 344).**

1.2.3.5 Waste colonialism

Not only is this failure to recognise the 'politics of entanglement' a source of injustice within the organics management sector, but placing the responsibility of removing physical, biological and chemical contaminants from the organics cycle on local authorities, communities, individuals, and whānau is an extended and covert form of colonialism: waste colonialism.

Waste colonialism is a term used to describe the ways in which the disposal of waste (and contamination more broadly) can be used as a tool of colonisation. Waste colonialism occurs when the disposal of waste is used to exert control over Indigenous lands and communities, and to undermine Indigenous rights and self-determination (Fuller et al. 2022). Fuller et al. discuss in reference to plastics pollution:

> **"Most plastics in circulation do not arrive in countries as 'waste'; their slow violence and deep time implications are concealed in the state-sanctioned legitimization of packaged products as *everyday consumer goods*".**

The challenge of dealing with imported products that enter the waste stream is an issue rooted in globalisation. As such, focusing on local interventions alone to limit and prevent waste from entering food scraps collections, or other organics waste streams is a continuation of the oppression of marginalised communities. This rhetoric is perpetuated by multinational companies to manipulate consumers to put the onus on themselves (Park 2022).

Fuller et al. (2022) conclude that "sustainable solutions to plastics pollution for Te Moananui can only come from urgent, locally and globally coordinated and integrated, critically reflexive, and intentional, decolonial responses."

The role of waste colonialism as a root cause for contamination and the consequential state of food insecurity are underlying mechanisms that inhibit Māori autonomy, security, and self-determination through food sovereignty. With respect to the Hua Parakore principles, this should be recognised as the contamination of *mana*.

While there are many approaches that can reduce contamination of organics management systems, which are covered in Chapter 4 of this report, ultimately, the root causes of contamination (which are connected to the global challenge of plastic waste and chemical pollution / novel entities) can only be addressed through ambitious and concerted efforts from the international community, including the private sector. This can be achieved through the implementation of extended producer responsibility schemes, such as reuse and refill systems, container deposit or return systems, product stewardship regulations, materials and product bans, and remediation initiatives – actions aimed at capping the production of plastics and all novel entities (Persson et al. 2022, p. 1517), and rapidly restricting their use wherever possible (Cousins et al. 2022). Such measures will require commitment and cooperation from all stakeholders to effectively mitigate the "*transboundary flow*" of novel entities entering the organics cycles.

2 Part 2: Key practices and interventions for preventing and reducing contamination

Part 2 of this Chapter covers key approaches to mitigating common sources of contamination in food scraps and garden organics feedstocks, largely from kerbside collections (for discussion on how localised approaches (e.g. onsite/home composting, small and medium-scale collections and processing facilities) mitigate contamination, see Chapter 3 – Localising Organics. This report should be read alongside the 2023 Ministry for the Environment-commissioned study into organics contaminants in Aotearoa New Zealand ('Options for Contaminants in Organic Waste', ref. 1224-01-RFP). Mitigating contamination of other types of organic materials (e.g. sewage sludge, industrial by-products) are largely out of scope of this literature review, though can be addressed by some of the approaches outlined below. It is also important to note that most, if not all, interventions will require some form of practicable and cost-effective compliance and enforcement regimes, without which interventions may not be effective, but discussion of such regimes is also out of scope of this report.

2.1 Multifaceted approach

While the literature identified a wide range of approaches to address contamination, combining these in a comprehensive and coordinated way was considered best practice. This includes combining regulation, comprehensive contamination management plans, effective system design/methodology, communications and educational materials, swift and targeted interventions, and more (Isenhour et al. 2016, pp. 19 & 24; WRAP 2010; ICF Incorporated 2021a, p. 30; Hyder 2012, pp. 95-96).

The Australian Government *Best Practice Collection Manual* provides several case studies where success was determined by a multifaceted approach. For example, the effectiveness of the scheme in Canterbury, Sydney, was achieved through intensive consultation with the target community to develop effective communications content, alongside rigorous contamination management procedures that included inspections, reporting and rejecting contaminated bins by collectors, and targeted compliance programs (pp. 96-97).

2.2 Regulatory tools

Many sources identified regulatory interventions as being critical for reducing contamination both of feedstocks and resulting composts. Regulations such as mandatory source separation, feedstock restrictions and product bans/phase-outs largely aim to prevent contaminants entering the materials streams in the first place. Some regulatory tools such as contamination thresholds and compost/digestate quality standards focus further downstream, but do disincentivise contaminated loads from being collected and processed and eventually, in theory, disincentivise contamination from occurring.

2.2.1 Source separation

Ensuring feedstocks are separated at source has long been shown to reduce contamination risk (Richard 2005; Thakali et al. 2022, pp. 5-6; Hyder 2012, p. 38). Mixed food and garden organics (FOGO) bins are generally perceived to have higher rates of contamination than separate food and garden collections (Hyder 2012, p. 48; Harrington 2015; Ministry for the Environment 2005, p. 12). Thakali et al. (2022) also found that, contrary to expectations, mandatory (regulated) source-separation overall resulted in less contamination than voluntary (unregulated) separation among their samples (pp. 5 & 10). This indicates that source separation can be a powerful tool for behaviour change in terms of user engagement with waste and collection systems.

Some contaminants are more likely to be present in particular feedstocks, so keeping these separate could help to manage and isolate contamination. PFAS levels, for example, are highest in composts derived from biosolids, followed by food, and lowest in garden waste (ICF Incorporated 2021b, p. 5), whereas persistent herbicides are far more likely to come from garden, manure or hay feedstocks rather than food (p. 45).

2.2.2 Restricting feedstocks

Some problematic products and materials (particularly those containing chemical contaminants) can still contaminate source separated feedstocks. Restricting certain feedstocks from being collected and/or processed can help mitigate these. This has been shown to work for preventing contamination with persistent herbicides (excluding horse manure and bedding from accepted feedstocks) (ICF Incorporated 2021b, 63-64).

Compostable products and packaging and other food contact materials have been identified as significant sources of PFAS contamination of food waste feedstocks (pp. 17-20; Thakali et al. 2022, p. 9), and could be managed by restricting acceptance of food contact materials (p. 10). While some product types are less likely to contain fluorinated chemicals than others (ICF Incorporated 2021b, p. 17), they may introduce other issues such as adding operational complexity and increasing costs, degrading compost quality (and therefore marketability), affecting methane production rates in anaerobic digestion facilities, and may increase the incidence of conventional plastics contaminating feedstocks due to people’s confusion and inability to distinguish them from compostables (ICF Incorporated 2021a, pp. 35-36; Hyder 2012, p. 49).

Chapter 4 of Wilkinson et al. (2019, pp. 70-79) contains an extensive and in-depth list of feedstocks and their relative risk of contamination which will be useful in determining which feedstocks should/should not be accepted in collections and processing facilities.

2.2.3 Phase-outs/bans

Product bans/phase-outs were identified as a direct approach to eliminating risk where feedstocks are commonly contaminated. Regulating products (and their producers) that cause contamination is considered a fairer approach than regulations targeting organics processors, and is particularly important in countries like the US that have permissive, free-market oriented chemical regulatory regimes, where harms from chemical contamination often don’t arise until they have already occurred (Isenhour et al. 2022, pp. 348-349).

Bans/phase-outs could apply to a wide range of products, materials, and ingredients (i.e. chemical additives in packaging and other products). As a starting point, this might include bans on easily identifiable and frequent contaminants, such as non-compostable plastic produce stickers (as has occurred in NZ), which can encourage the development of alternative means of packaging/labelling goods (ICF Incorporated 2021a, p. 32). Work on the global plastics treaty includes mechanisms for developing and overseeing lists of polymers and associated chemicals of concern to be eliminated or regulated (see Scientists' Coalition for an Effective Plastics Treaty 2023b, p. 4), which if implemented would be a significant means of preventing the contamination of organic materials, particularly food waste.

Bans/phase-outs can also apply to common sources of chemicals of concern such as PFAS. The US EPA discuss options such as:

- outright bans of the use of PFAS in food packaging (as a common source of food waste contamination) as some States in the U.S. have done.
- restricting/banning use of products that contain PFAS (aka 'source control', overlapping with restricting feedstocks).
- ensuring that such bans apply both to manufacture/use within the country and to imported products containing PFAS (ICF Incorporated 2021b, p. 63).

2.2.4 Setting contamination thresholds

Setting maximum thresholds for contamination of loads at processing facilities can help to identify and prevent contamination from entering processing facilities. In theory, this can help disincentivise contamination from occurring if combined with other actions.

California has set the maximum threshold at 1% of physical contaminants of loads and has set requirements for daily screening and inspection by processors (Thomsen Reuters Westlaw, §17868.5). Scotland's contamination threshold is much higher at 5%, which was perceived to be "the norm rather than the exception" by several operators interviewed as part of a 2017 Scottish composting sector survey (Aspray et al. 2019, p. 11).

This demonstrates that such thresholds are important to get right: a high threshold can breed complacency, but too stringent a threshold can place unfair burden on processors if there isn't adequate regulation and efforts to reduce contamination further upstream. As noted above, targeting regulations at the processor level can be both unfair and ineffective (Isenhour et al. 2022).

2.2.5 Mandatory product standards and use restrictions

Developing mandatory compost and digestate standards and/or usage guidelines/restrictions can help to identify and prevent contamination (ICF Incorporated, 2021b, p. 64). This can include setting a total maximum contamination threshold of compost/digestate by weight (primarily targeting physical contaminants) as well as maximum concentrations of chemical contaminants of concern, and such thresholds could be part of comprehensive standards that cover a wide range of metrics (including nutrient values etc.). Standards for managing emerging chemical pollutants, such as PFAS and other POPs, currently do not exist (p. 54), but require urgent attention (Thakali 2022, pp. 9-10).

California defines compost and/or digestate suitable for land application as that which "does not contain more than 0.5% by dry weight of physical contaminants greater than 4 millimeters (no more than 20% by dry weight of this 0.5% shall be film plastic greater than 4 millimeters)" as well as maximum metal concentrations and pathogen density (Thomsen Reuters Westlaw, §17852, 24.5).

However, the US EPA found that such regulations missed a wide range of plastic fragments that are smaller than 4mm, noting that such thresholds less about risk and more about available methodology (ICF Incorporated, 2021a, p. 24). They also argued that "in some cases, aesthetic concerns... and the capabilities of common screening and detection methodologies influenced standards," which could lead to the perverse outcome where:

> **"compliance could be achieved by reducing the size of plastic fragments in the compost or digestate through additional grinding—thereby decreasing the amount of larger plastic particles but increasing the amount of smaller particles that are present in the compost or digestate" (p. 29).**

In addition to standards, use restrictions could be developed for different soil amendments based on feedstock types, contamination concentrations and other factors. For example, composts could be graded for use as either landfill cover, soil amendments for forest restoration, rural farmland use, urban gardens etc., depending on whether or not they exceed contamination thresholds, or used risky feedstocks (ICF Incorporated, 2021b, p.64).

NZ currently only has a voluntary composting standard (NZS4454:2005, based on the Australian voluntary standard AS4454), which has no accreditation pathway and is designed only for the large-scale commercial context (i.e. it does not neatly apply to home/on-site, small and medium-scale composting operations. In terms of contamination, the Australian standard has been deemed inadequate in a comprehensive study of the Queensland composting sector:

> AS4454... only covers a relatively narrow group of contaminants including some metals, selected organic chemicals, nutrients, pathogens and physical impurities. AS4454 was never developed to deal with the broad range of potential contaminants that may be introduced from the various industrial and regulated waste streams that are used in some Queensland composting facilities (Wilkinson et al. 2019, p. 176).

There is also uncertainty and more research needed to ascertain what constitutes safe levels of emerging chemical contaminants in composts and digestates, and whether the degree of contamination commonly found is also safe (ICF Incorporated 2021b, p. 62). A certification scheme for anaerobic digestates is also currently being developed in Aotearoa New Zealand (Bioenergy Association 2022), and it remains to be seen how far this work will go to address emerging contaminants of concern.

As with contamination thresholds, standards must be seen as a downstream intervention, meaning the desired effect can take time to filter through, and may place an unfair burden on processors to meet the requirements. This could be somewhat mitigated by requiring standards to be mandatory, which levels the playing field among processors, but may require additional supportive measures as testing for contaminants can be expensive, slow and complicated (Isenhour et al. 2022, p. 348).

2.3 Contamination management plan

The need to develop comprehensive plans and procedures for contamination management was seen as crucial in practical guideline sources (Hyder 2012, p. 95; WRAP 2016a; Harrington 2015). Such plans should include multiple aspects, from education/communication materials, tools to manage contamination upon collection, regular monitoring and evaluation/auditing, design features to minimise contamination and more.

The plans should also involve multiple actors within the system, from collectors & processors, territorial authorities, to generators (including nominated monitors and volunteers for shared spaces such as workplaces and apartment blocks).

Such plans work most effectively when various aspects are combined with regulatory tools. For example, education campaigns or technical assistance combined with economic or policy incentives (e.g. Pay-As-You-Throw) or mandates (e.g. contamination thresholds, mandatory inspections and reporting, fines) (Isenhour et al. 2016, pp. 19 & 24).

2.3.1 Cart/bin-tagging/labelling

Cart- or bin-tagging/labelling and use of feedback cards were mentioned several times as an effective and efficient tool for addressing contamination (Hyder 2012 pp. 95-96; Kaufman et al. 2020, p. 33; ICF Incorporated 2021a. p. 31). This involves rejecting containers/bins that have excessive contamination and notifying the offender why the container was not collected by using a bin sticker/label. This the tag/label/sticker can be supplemented with a feedback card left with the offender giving a more detailed explanation. Again, it was noted that this approach requires enforcement to be effective (ibid.), which could include fines or removing bins entirely where serious contamination occurs repeatedly (WRAP 2016a, p. 11).

2.3.2 Swift and targeted interventions

A key part of a management plan is provision to address any sources of contamination as quickly as possible – nipping it in the bud. For such cases, targeted interventions are considered more effective than widespread actions such as doubling down on communications or education campaigns (Rawtec 2018, p. 27). It also requires a degree of agility to be present in the system, so that containers/bins can be adapted (e.g. changing location or adding attachments) or even removed if necessary (WRAP 2016a, p. 11).

In one successful example, one of WRAP's (UK) food scraps collection trials in the mid-2000s experienced very high contamination (as much as 40% of containers) in "less affluent areas" early on. The levels of contamination were swiftly and effectively brought drastically down through bin tagging, enhanced communications and "door-to-door canvassing" (Bridgwater & Parfitt 2009, p. 64).

2.3.3 Practical design features

Several sources discussed various practical design features in organics management systems to prevent and reduce contamination, including the ability to change/redesign aspects where necessary (WRAP 2010). Choosing which features are most appropriate depends largely on the context – e.g. where organics collections are combined with other (recycling and residual waste) collection services, and the processing type(s) used and degree of sorting/pre-screening at facility. Ultimately these features should be part of the wider contamination management plan. Design features may include:

- Collection frequency (e.g. weekly, fortnightly).
- Container size/types – e.g. standardised food-only bins, FOGO bins (and how large), bags (see Ministry for the Environment 2005, p. 5).
- Whether to provide compostable bin liners and/or kitchen caddies – liners are generally perceived to reduce contamination (ICF 2021a, p.16; Eunomia Research & Consulting Ltd 2011, p.22; WRAP 2016a, pp. 6-7).
- Appropriate locations for organics containers/bins, particularly in shared areas like MUDs (p. 11) and schools (Eunomia Research & Consulting Ltd 2011, p. 24) – e.g. away from residual waste bins and in areas where contamination is more likely, and near "key waste production points" for businesses (p. 23).
- Container adaptations/accessories, e.g. lockable containers (ibid.), bin 'housing units' (WRAP, 2016a, p.5) and/or changes to container aperture (p. 11).

A common perception/concern is that reducing the collection frequency or bin size for residual waste to increase diversion raises the risk of contaminating organics bins (Harrington 2015), though this is not necessarily the case (Hyder 2012, p. 27).

2.3.4 Communications

Communications and educational resources are a critical part of any contamination management plan (WRAP 2010; Eunomia Research & Consulting Ltd 2011, p. 23; WRAP 2016a; Aspray et al. 2019, p. 18; ICF Incorporated 2021a, p. 30-31; Hyder 2012). Comms not only inform users of a service how exactly it works, what can/cannot be accepted and why, why using the service correctly is important etc. but can accompany many other aspects of contamination management procedures (e.g. bin-tagging, targeted interventions).

Good comms should be used at every stage of a project – from well before the introduction of the service, immediately before and during the roll-out, and as an ongoing means of informing and engaging participants, media, local government staff and elected officials and other stakeholders. They could include printed materials, face-to-face comms, resources for food service providers on appropriate packaging, and could be delivered by volunteer monitors in shared spaces such as MUDs. Consultation with target communities was shown to be effective in Sydney (Hyder, 2012, pp. 96-97), and helped to develop appropriate terminology that made sense to participants (e.g. 'garden vegetation' instead of green waste or garden organics (p. 55)).

Again, comms and education materials are often ineffective on their own and need to be combined within a comprehensive plan that includes regulatory requirements, incentives and enforcement (Isenhour et al. 2016, pp. 19 & 24; Bridgwater & Parfitt 2009, p. 64). This was the experience in Washington State after a failure of an information campaign led to the development of a more comprehensive strategy, including more targeted and sophisticated comms (ICF Incorporated 2021a, p. 30).

There are many considerations and potential approaches to achieving successful and engaging communications, which is not explored in depth in this literature review. However, Kaufman et al. (2020) identify 'social modelling' as a particularly effective comms approach for behaviour change, and reference a study (Bernstad et al. 2013) that found it was particularly effective for reducing food waste contamination. Social modelling involves "passing on information via demonstration or discussion in which the initiators indicate that they personally engage in the behaviour" (Kaufman et al. 2020, p. 33). Efforts to engage residents via gamification have proven successful, such as the use of a bingo card in some Washington State Counties that residents could fill with produce stickers and exchange for free compost when full (Harrington 2015). The approach taken in the City to Soil programme in Queanbeyan, New South Wales, Australia, where attempts were made to connect organics collection users to the soil fertilisation and improvement outcomes for farmers appeared to improve contamination outcomes (Gillespie 2009).

2.3.5 Contracts

Some sources noted it was critical that contamination mitigation procedures and policies are written into contracts (for collection and processing providers) to set expectations and best practice from the outset (ICF Incorporated 2021a, p. 32; Harrington 2015; Hyder 2012, pp. 22 & 84). Contracts should include contamination inspection and monitoring requirements, the authority to reject contaminated containers or loads based on an agreed (or mandated) threshold, and provisions for compensation for rejecting excessively contaminated loads. Without clear contracts, processors and/or collectors have been shown to accept contaminated loads where they otherwise may not, both for commercial viability and for fear of legal repercussions of sending collections to landfill (Harrington 2015; Aspray et al. 2019, p. 12).

2.3.6 Stakeholder relationships and consultation

Fostering relationships between various stakeholders, and engaging in stakeholder consultation, were seen as important ways to build trust, enhance collaboration, identify risks and create ambassadors that help ensure the success of an organics contamination management plan (ICF International 2021a, p. 32; Harrington 2015; Aspray et al. 2019, p. 18; WRAP 2016a, p. 10; WRAP 2016b, pp. 3-4; Hyder 2012, pp. 33-35). These can be facilitated through direct contact, regular forums or one-off events on certain topics, tours of processing facilities or food businesses demonstrating good practice, and by training key staff or volunteers to monitor contamination and be spokespeople for its management.

Stakeholders should be identified early on, and engagement should be sought with key parts of the food industry (producers/manufacturers, packaging and serviceware companies, retail and hospitality), local and regional authorities, organics processors and collectors, key staff/volunteers, and community/neighbourhood groups.

Isenhour et al. (2022) discuss how crucial some organics processors feel that good relationships and regular communication with organic waste generators are for reducing contamination, and yet such relationships are becoming increasingly difficult as organics management expands to include numerous generators in residential and institutional sectors (p. 348).

Appendix A - References

Aspray T, Menzies B, Dimambro M 2019. Scottish Composting Sectory Survey 2017. Prepared for Zero Waste Scotland. 20 p. https://www.researchgate.net/publication/334670851_Scottish_composting_sector_survey_2017 (accessed 28/11/2023)

Barlow C, Wineti E 1991. Tikanga whakaaro: Key concepts in Maori culture. Auckland, Oxford University Press.

Bioenergy Association 2022. Project: Programme to avoid digestate disposal to landfill: Securing beneficial use of digestate via biofertiliser certification. New Plymouth, Bioenergy Association. 3 p. https://www.biogas.org.nz/documents/resource/Certification%20of%20biofertiliser%20-%20project%20summary%20220619.pdf (accessed 28/11/2023)

Bridgwater E, Parfitt J 2009. Evaluation of the WRAP Separate Food Waste Collection Trials. Written by Resource Futures Ltd for WRAP. Banbury, Waste & Resources Action Programme. 83 p. https://wrap.org.uk/sites/default/files/2021-08/Evaluation%20of%20the%20WRAP%20FW%20Collection%20Trials%20Update%20June%202009.pdf (accessed 28/11/2023)

Cousins IT, Johansson JH, Salter ME, Sha B, Scheringer M 2022. Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS). Environmental Science & Technology 56: 11172-11179. https://doi.org/10.1021/acs.est.2c02765

de Souza Machado AA, Kloas W, Zarfl C, Hempel S, Rillig MC 2017. Microplastics as an emerging threat to terrestrial ecosystems. Global Change Biology 24: 1405-1416. https://doi.org/10.1111/gcb.14020

EIA 2023. Cultivating Plastic: Part 1 – Agriplastics and the UK grocery retail supply chain. London, Environmental Investigation Agency. 14 p. https://eia-international.org/wp-content/uploads/2023-EIA-UK-Cultivating-Plastic-Agriplastics-SPREADS.pdf (accessed 28/11/2023)

Eunomia Research & Consulting Ltd 2011. Collecting food waste from small businesses and schools. Report prepared for WRAP. Banbury, Waste & Resources Action Programme. 74 p. https://wrap.org.uk/sites/default/files/2020-10/WRAP-collecting-food-waste-small-businesses-schools.pdf (accessed 28/11/2023)

Easton, B. (2020). Not in Narrow Seas: The Economic History of Aotearoa New Zealand. New Zealand: Victoria University of Wellington Press.

FAO 2023. Global Forum on Food Security and Nutrition (FSN Forum): Towards the development of a Voluntary Code of Conduct on the sustainable use of plastics in agriculture. Food and Agriculture Organization of the United Nations website. https://www.fao.org/fsnforum/call-submissions/voluntary-code-conduct-sustainable-use-plastics-agriculture (accessed 28/11/2023)

FAO 2021. Assessment of agricultural plastics and their sustainability. A call for action. Rome, Food and Agricultural Organization of the United Nations. https://doi.org/10.4060/cb7856en

Flaws J, Damdimopoulou P, Patisaul HB, Gore A, Raetzman L, Vandenberg LN 2020. Plastics, EDCs & Health: A guide for public interest organizations and policy-makers on endocrine disrupting chemicals & plastics. Report by the Endocrine Society and IPEN (International Pollutants Elimination Network). 92 p. https://www.endocrine.org/topics/edc/plastics-edcs-and-health (accessed 29/11/2023)

Fuller S, Ngata T, Borrelle S, Farrelly T 2022. Plastics pollution as waste colonialism in Te Moananui. Journal of Political Ecology 29 (1): 534-560. https://doi.org/10.2458/jpe.2401

Gaukroger S 2008. The Emergence of a Scientific Culture: Science and the Shaping of Modernity 1210-1685. Oxford, Clarendon Press.

Gillespie G 2009. Chapter 27: City to Soil: Returning Organics to Agriculture – A Circle of Sustainability. In: Woods WI, Teixeira WG, Lehmann J, Steiner C, WinklerPrins A, Rebellato L eds. Amazonian Dark Earths: Wim Sombroek's Vision. Dordrecht, Springer. Pp. 465-472.

Harrington M 2015. Controlling Contamination in Collected Organics: The Washington Department of Ecology, local governments and composters are working together to identify reasons behind increasing amounts of physical contamination and ways to reduce it. BioCycle. https://www.biocycle.net/controlling-contamination-in-collected-organics/ (accessed 29/11/2023)

Hebrok M, Boks C 2017. Household food waste: Drivers and potential intervention points for design – An extensive review. Journal of Cleaner Production 151: 380-392. https://doi.org/10.1016/j.jclepro.2017.03.069

Hickel, J. (2020). Less is More: How Degrowth Will Save the World. United Kingdom: Random House.

Huerta Lwanga E, Gertsen H, Gooren H, Peters P, Salánki T, van der Ploeg M, Besseling E, Koelmans AA, Geissen V 2016. Microplastics in the Terrestrial Ecosystem: Implications for *Lumbricus terrestris* (Oligochaeta, Lumbricidae). Environmental Science & Technology 50 (5): 2685-2691. https://doi.org/10.1021/acs.est.5b05478

Hutchings J 2020. Te mahi māra hua parakore: A Māori food sovereignty handbook. Ōtaki, Te Tākupu, Te Wānanga o Raukawa.

Hutchings J, Smith J, Harmsworth G 2018. Elevating the mana of soil through the Hua Parakore Framework. MAI Journal 7 (1): 92-102. https://doi.org/10.20507/MAIJournal.2018.7.1.8

Hutchings J, Tipene P, Carney G, Greensill A, Skelton P, Baker M 2012. Hua parakore: an indigenous food sovereignty initiative and hallmark of excellence for food and product production. Mai Journal 1 (2): 131-145. https://www.journal.mai.ac.nz/content/hua-parakore-indigenous-food-sovereignty-initiative-and-hallmark-excellence-food-and-product (accessed 29/11/2023)

Hyder 2012. Food and Garden Organics: Best Practice Collection Manual. Prepared for the Department of Sustainability, Environment, Water, Population and Communities. Canberra, Australian Government. 158 p. https://www.awe.gov.au/sites/default/files/documents/collection-manual.pdf (accessed 28/11/2023)

ICF Incorporated 2021a. Emerging Issues in Food Waste Management: Plastic Contamination. Report prepared for the U.S. Environmental Protection Agency (EPA), Office of Research and Development. 64 p. https://www.epa.gov/system/files/documents/2021-08/emerging-issues-in-food-waste-management-plastic-contamination.pdf (accessed 29/11/2023)

ICF Incorporated 2021b. Emerging Issues in Food Waste Management: Persistent Chemical Contaminants. Report prepared for the U.S. Environmental Protection Agency (EPA), Office of Research and Development. 95 p. https://www.epa.gov/system/files/documents/2021-08/emerging-issues-in-food-waste-management-persistent-chemical-contaminants.pdf (accessed 29/11/2023)

Isenhour C, Haedicke M, Berry B, MacRae J, Blackmer T, Horton S 2022. Toxicants, entanglement, and mitigation in New England’s emerging circular economy for food waste. Journal of Environmental Studies and Sciences 12: 341-353. https://doi.org/10.1007/s13412-021-00742-w

Isenhour C, Blackmer T, Wagner T, Silka L, Peckenham J, Hart D, MacRae J 2016. Moving up the Waste Hierarchy in Maine: Learning from “Best Practice” State-Level Policy for Waste Reduction and Recovery. Maine Policy Review 25 (1): 15-29. https://doi.org/10.53558/VZUB1903

Kaufman S, Meis-Harris J, Spanno M, Downes J 2020. Reducing Contamination of Household Recycling: A Rapid Evidence and Practice Review for Behavioural Public Policy. Report prepared for the BWA Waste and Circular Economy collaboration, BehaviourWorks Australia, Monash University. 64 p. https://uploads-ssl.webflow.com/619ab5836de9f00d9c722d98/61df702ae0198ac4b45af0e3_Recycling-contamination_Rapid-review_FULL-REPORT.pdf (accessed 29/11/2023)

Kennedy AM, McGouran C, Kemper JA 2020. Alternative paradigms for sustainability: A Relational worldview. European Journal of Marketing 54 (4): 825–855. https://doi.org/10.1108/EJM-01-2018-0043

Khalid N, Aqeel M, Noman A 2020. Microplastics could be a threat to plants in terrestrial systems directly or indirectly. Environmental Pollution 267: 115653. https://doi.org/10.1016/j.envpol.2020.115653

Longhurst PJ, Tompkins D, Pollard SJT, Hough RL, Chambers B, Gale P, Tyrell S, Villa R, Taylor M, Wu S, Sakrabani R, Litterick A, Snary E, Leinster P, Sweet N 2019. Risk assessments for quality-assured, source-segregated composts and anaerobic digestates for a circular bioeconomy in the UK. Environment International 127: 253-266. https://doi.org/10.1016/j.envint.2019.03.044

Marsden M 1992. God, man and universe: A Maori view. In: King M ed. Te Ao Hurihuri: Aspects of Maoritanga. Reed. Pp. 117–137.

Marsden M 2003. The Woven Universe: Selected Writings of Rev. Māori Marsden. Estate of Rev. Māori Marsden.

Marsden M, Henare TA 1992. Kaitiakitanga: A Definitive Introduction to the Holistic Worldview of the Māori. Report prepared for the Ministry for the Environment. Wellington, Ministry for the Environment. 21 p.

Masuzawa T 2005. The invention of world religions: Or, how European universalism was preserved in the language of pluralism. Chicago, University of Chicago Press.

Matthews J 2014. Rural waste surveys data analysis Waikato & Bay of Plenty. Report prepared by GHD Ltd for Waikato Regional Council. Hamilton, Waikato Regional Council. 83 p. https://waikatoregion.govt.nz/assets/WRC/WRC-2019/TR201455.pdf (accessed 30/11/2023)

McAloon J 2013. Resource frontiers, environment, and settler capitalism: 1769-1860. In: Pawson E, Brooking T eds. Making a new land: environmental histories of New Zealand. Dunedin, University of Otago Press. Pp. 70-85

McFarlane TR 2007. The contribution of taewa (Maori potato) production to Maori sustainable development. Unpublished Master of Applied Science Thesis, Lincoln University, Christchurch, New Zealand.

McKerchar C, Bowers S, Heta C, Signal L, Matoe L 2015. Enhancing Māori food security using traditional kai. Global Health Promotion 22 (3): 15–24. https://doi.org/10.1177/1757975914543573

McKiernan C 2015. Special Report: Organics: Containing Food Waste Contamination Essential for Anaerobic Digestion. Waste360. https://www.waste360.com/organics/containing-food-waste-contamination-essential-anaerobic-digestion (accessed 30/11/2023)

Mead HM 2016. Tikanga Māori: Living by Māori Values (revised edition). Wellington, Huia.
Merchant C 1980. The death of nature: Women, ecology, and the scientific revolution. New York, HarperCollins Publishers.

Milbrath LW, Fisher BV 1984. Environmentalists: Vanguard for a new society. New York, Suny Press.
Ministry for the Environment 2023. Te Rautaki Para | Waste Strategy: Getting rid of waste for a circular Aotearoa New Zealand. Wellington, New Zealand Government. 56 p. https://environment.govt.nz/assets/publications/Te-rautaki-para-Waste-strategy.pdf (accessed 30/11/2023)

Ministry for the Environment 2022a. Compostable products: Ministry for the Environment position statement. Wellington, New Zealand Government. 23 p. https://environment.govt.nz/assets/publications/compostables-packaging-position-statement.pdf (accessed 30/11/2023)

Ministry for the Environment 2022b. Te hau mārohi ki anamata | Towards a productive, sustainable and inclusive economy: Aotearoa New Zealand's First Emissions Reduction Plan. Wellington, New Zealand Government. 348 p. https://environment.govt.nz/assets/publications/Aotearoa-New-Zealands-first-emissions-reduction-plan.pdf (accessed 30/11/2023)

Ministry for the Environment 2005. Options for Kerbside Collection of Household Organic Wastes. Wellington, Ministry for the Environment. 30 p. https://environment.govt.nz/assets/Publications/Files/kerbside-collection-organic-wastes-may05.pdf (accessed 30/11/2023)

Morgan TKKB 2006. Waiora and cultural identity: Water quality assessment using the Mauri Model. AlterNative: An International Journal of Indigenous Peoples 3 (1): 42–67. https://doi.org/10.1177/117718010600300103

Mukherjee R, Pandya P, Baxi D, Ramachandran AV 2021. Endocrine Disruptors–'Food' for Thought. Proceedings of the Zoological Society 74: 432–442. https://doi.org/10.1007/s12595-021-00414-1

Ngata T, Liboiron M 2020. Māori plastic pollution expertise and action in Aotearoa. CLEAR. https://civiclaboratory.nl/2020/07/13/maori-plastic-pollution-expertise-and-action-in-aotearoa/ (accessed 29/11/2023)

Padhye LP, Kah M, Baron G, Taleb N 2023. Compostable Products in Aotearoa New Zealand. Report prepared by the University of Auckland for The Ministry for the Environment. Auckland, University of Auckland. 62 p. Unpublished.

Panelli R, Tipa G 2009. Beyond foodscapes: Considering geographies of Indigenous well- being. Health & Place 15 (2): 455–465. https://doi.org/10.1016/j.healthplace.2008.08.005

Park W 2022. How companies blame you for climate change. BBC. https://www.bbc.com/future/article/20220504-why-the-wrong-people-are-blamed-for-climate-change (accessed 30/11/2023)

Parliamentary Commissioner for the Environment 2018. Biodegradable and Compostable Plastics in the Environment. https://pce.parliament.nz/publications/biodegradable-and-compostable-plastics-in-the-environment/ (accessed 30/11/2023)

Patel R Guest Editor 2009. Food sovereignty. The Journal of Peasant Studies 36 (3): 663–706. https://doi.org/10.1080/03066150903143079

PDP 2018. Impact of Per and Poly Fluoroalkyl Substances on Ecosystems. Prepared by Pattle Delamore Partners (PDP) Ltd for Ministry for the Environment. 130 p. https://environment.govt.nz/assets/final-impact-of-pfas-on-ecosystems.pdf (accessed 30/11/2023)

Pehi P, Kanawa L, Lambert S, Allen W 2009. The Restitution of Marae and Communities Through Mahinga Kai: Building the management of Maori Customary Fisheries. Report prepared by Nga Pae o Te Maramatanga and Otago University. 40 p. https://www.maramatanga.ac.nz/sites/default/files/Pehi%20Web%20ready_0.pdf (accessed 30/11/2023)

Persson L, Almroth BMC, Collins CD, Cornell S, de Wit CA, Diamond ML, Fantke P, Hassellöv M, MacLeod M, Ryberg MW, Jørgensen PS, Villarrubia-Gómez P, Wang Z, Hauschild MZ 2022. Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. Environmental Science & Technology 56 (3): 1510-1521. https://doi.org/10.1021/acs.est.1c04158

Rawtec 2018. Analysis of NSW Food and Garden Bin Audit Data. Report by Rawtec Pty Ltd for New South Wales Environment Protection Authority. 60 p. https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/managewaste/nsw-fogo-analysis.pdf?la=en&hash=F2F341DB7CF6C517801CD04DBBCFA389C03DF82A (accessed 30/11/2023)

Richard TL, Woodbury PB 2005. Municipal Solid Waste Composting: Strategies for Separating Contaminants. Cornell Composting, Resources: MSW Composting Fact Sheets. http://compost.css.cornell.edu/MSWFactSheets/msw.fs3.html (accessed 30/11/2023)

Richardson K, Steffen W, Lucht W, Bendtsen J, Cornell SE, Donges JF, Drüke M, Fetzer I, Bala G, von Bloh W, Feulner G, Fiedler S, Gerten D, Gleeson T, Hofmann M, Huiskamp W, Kummu M, Mohan C, Nogués-Bravo D, Petri S, Porkka M, Rahmstorf S, Schaphoff S, Thonicke K, Tobian A, Virkki V, Wang-Erlandsson L, Weber L, Rockström J 2023. Earth beyond six of nine planetary boundaries. Science Advances 9 (37). https://doi.org/10.1126/sciadv.adh2458

Rillig MC, Lehmann A 2020. Microplastic in terrestrial ecosystems. Science 368 (6498): 1430-1431. https://doi.org/10.1126/science.abb5979

Sachdev PS 1989. Mana, Tapu, Noa: Maori cultural constructs with medical and psycho-social relevance. Psychological Medicine 19 (4): 959–969. https://doi.org/10.1017/S0033291700005687

Sarker A, Deepo DM, Nandi R, Rana J, Islam S, Rahman S, Hossain MN, Islam MS, Baroi A, Kim J-E 2020. A review of microplastics pollution in the soil and terrestrial ecosystems: A global and Bangladesh perspective. Science of the Total Environment 733: 139296. https://doi.org/10.1016/j.scitotenv.2020.139296

Scientists' Coalition for an Effective Global Plastics Treaty, Wagner M, Brander, SM, Almroth BC, Courtene-Jones W, Fernandez M, Groh K, Gündoğdu S, Hartmann NB, Weis J 2023a. Policy Brief: Role of chemicals and polymers of concern in the global plastics treaty. Zenodo. 3p. https://doi.org/10.5281/zenodo.7941525

Scientists' Coalition for an Effective Plastics Treaty 2023b. Response to the Zero Draft text of the international legally binding instrument on plastic pollution, including in the marine environment (UNEP/PP/INC.3/4). Submission to the United Nations Environment Programme (UNEP). 10 p. https://ikhapp.org/wp-content/uploads/2023/11/Scientists-Coalition-Response-to-the-Zero-Draft-text-for-INC-3.pdf (accessed 30/11/2023)

Scopetani C, Chelazzi D, Cincinelli A, Martellini T, Leiniö V, Pellinen J 2022. Hazardous contaminants in plastics contained in compost and agricultural soil. Chemosphere 293: 133645. https://doi.org/10.1016/j.chemosphere.2022.133645

Scott F 2016. New Zealand Rural Waste Minimisation Project: Milestone 3 Phase II: Exploration of Potential Waste Minimisation Options. Report prepared by True North Consulting for Environment Canterbury. Christchurch, True North Business Services Limited. Available at https://tnc.co.nz/about/articles-publications/ (accessed 30/11/2023)

Shirley L 2013. Is Māori food sovereignty affected by adherence, or lack thereof, to Te Tiriti O Waitangi? Future of Food: Journal on Food, Agriculture and Society 1 (2): 46-50. https://www.thefutureoffoodjournal.com/index.php/FOFJ/article/view/211 (accessed 30/11/2023)

Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, Bennett EM, Biggs R, Carpenter SR, de Vries W, de Wit CA, Folke C, Gerten D, Heinke J, Mace GM, Persson LM, Ramanathan V, Reyers B, Sörlin S 2015. Planetary boundaries: Guiding human development on a changing planet. Science 347 (6223): 1259855. https://doi.org/10.1126/science.1259855

Stockholm Resilience Centre 2022. Safe planetary boundary for pollutants, including plastics, exceeded, say researchers. Stockholm University. https://www.stockholmresilience.org/research/research-news/2022-01-18-safe-planetary-boundary-for-pollutants-including-plastics-exceeded-say-researchers.html (accessed 30/11/2023)

Tawhai W 2013. Living by the moon. Wellington, Huia Publishers.

Te Waka Kai Ora 2023. What is Hua Parakore? https://www.tewakakaiora.co.nz/whatishuaparakore (accessed 30/11/2023)

Te Waka Kai Ora 2010. Te Reka o te Kai—Kai Atua: Maara Kai Practical Guide. Kaikohe, Te Waka Kai Ora.

Thakali A, MacRae JD, Isenhour C, Blackmer T 2022. Composition and contamination of source separated food waste from different sources and regulatory environments. Journal of Environmental Management 314: 115043. https://doi.org/10.1016/j.jenvman.2022.115043

Thomsen Reuters Westlaw (§17868.5). Barclays Official California Code of Regulations, Title 14, Division 7, Chapter 3.1., Article 7. https://govt.westlaw.com/calregs/Document/I99D0301C5B4D11EC976B000D3A7C4BC3 (accessed 30/11/2023)

Thomsen Reuters Westlaw (§17852). Barclays Official California Code of Regulations, Title 14, Division 7, Chapter 3.1., Article 1. https://govt.westlaw.com/calregs/Document/I989677945B4D11EC976B000D3A7C4BC3

UNEP 2022a. Historic day in the campaign to beat plastic pollution: Nations commit to develop a legally binding agreement. United Nations Environment Programme. https://www.unep.org/news-and-stories/press-release/historic-day-campaign-beat-plastic-pollution-nations-commit-develop (accessed 12/12/2023)

UNEP 2022b. Plastics in Agriculture – An Environmental Challenge. Foresight Brief 029. Nairobi, United Nations Environment Programme. 8 p.

https://wedocs.unep.org/bitstream/handle/20.500.11822/40403/Plastics_Agriculture.pdf (accessed 30/11/2023)

Viriaere H, Miller C 2018. Living Indigenous Heritage: Planning for Māori Food Gardens in Aotearoa/New Zealand. Planning Practice & Research 33 (4): 409–425. https://doi.org/10.1080/02697459.2018.1519931

WasteMINZ 2022. Our guidelines. https://www.wasteminz.org.nz/guidelines-on-compostable-and-biodegradable-packaging (accessed 30/11/2023)

White Jr L 1967. The historical roots of our ecologic crisis. Science 155 (3767): 1203–1207. https://www.jstor.org/stable/1720120

Wilkinson K, Biala J, Schliebs D, Hazall L 2019. Critical Evaluation of Composting Operations and Feedstock Suitability: Phase 2 – Contamination. Report prepared by Arcadis for Department of Environment and Science (DES Queensland). 301 p. https://environment.des.qld.gov.au/__data/assets/pdf_file/0022/226291/phase-2-composting-study-report.pdf (accessed 30/11/2023)

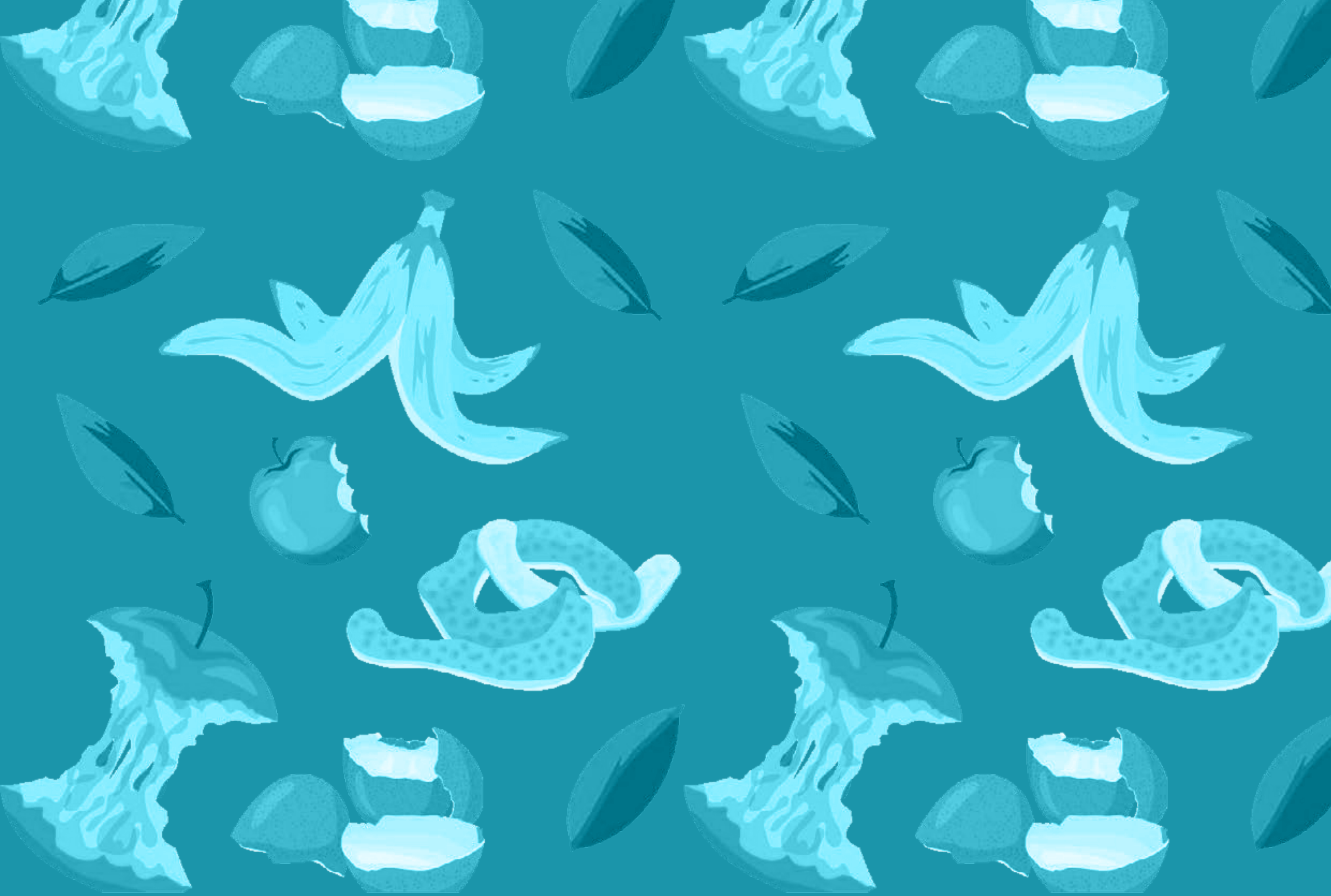
WRAP 2016a. Household food waste collections guide: Section 8: Collecting from flats. Banbury, Waste & Resources Action Programme. 20 p. https://wrap.org.uk/sites/default/files/2020-10/WRAP-HH_food_waste_collections_guide_section_8_collecting_from_flats.pdf (accessed 30/11/2023)

WRAP 2016b. Household food waste collections guide Section 10: Implementation. Banbury, Waste & Resources Action Programme. 6p. https://wrap.org.uk/sites/default/files/2021-10/HH%20food%20waste%20guide%20section%2010%202021%20final.pdf (accessed 30/11/2023)

WRAP 2010. Improving the performance of waste diversion schemes – A good practice guide to monitoring and evaluation. Report prepared by Resource Futures and WRAP. Banbury, Waste & Resources Action Programme. https://wrap.org.uk/sites/default/files/2021-06/WRAP-ME-Guidance-exec-summary-and-contents.pdf (accessed 30/11/2023)

Zhao C, Xin L, Xu X, Qin Y, Wu W 2022. Dynamics of antibiotics and antibiotic resistance genes in four types of kitchen waste composting processes. Journal of Hazardous Materials 424 (C): 127526. https://doi.org/10.1016/j.jhazmat.2021.127526

Zwolak A, Sarzyńska M, Szpyrka E, Stawarczyk K 2019. Sources of Soil Pollution by Heavy Metals and Their Accumulation in Vegetables: a Review. Water, Air, & Soil Pollution 230: 164. https://doi.org/10.1007/s11270-019-4221-y



Chapter 5

Opportunities for community

What role does the community want to play in the collection and processing of organics in the Waikato?

Rachel Glasier
Envision

ENVISION a zero waste world

February 2024

The focus of this study is to understand what role community organisations in the Waikato want to play in the collection and processing of organics and how they can be enabled to do more.

Contents of Chapter 5

Executive summary

The focus of this study is to understand what role community organisations in the Waikato want to play in the collection and processing of organics and how they can be enabled to do more.

To conduct this study, a qualitative research method was used to interview 20 people working in 19 organisations, most of whom are based in the Waikato region. This approach enabled a deeper understanding of community perspectives and allowed for relationships to be developed and strengthened. Organisations that participated included charitable trusts, social enterprises, schools and businesses. Participants were at various stages of development and most were operating small to medium scale services or enabling others in the community to do this work.

This investigation shows there is an active and passionate community participating in collections and processing of organic material. Those community organisations interviewed saw onsite, small-scale and medium scale (OSMS)[36] networks as a critical part of enabling food security and sovereignty while regenerating the natural environment. Most organisations communicated that building a OSMS model should be a core focus but also felt that a kerbside collection or other large scale facilities may be necessary. There was a shared view that a network approach should be developed to achieve the most favourable social, environmental and cultural outcomes for society, rather than purely economic outcomes.

There is a wealth of experience in the community and notable enthusiasm to do more. To support a robust organic material processing network, existing organisations can be enabled to scale up as well as tap into other networks, i.e. schools, community centres and community resource recovery centres. Scaling up could include providing service for businesses who have limited options available for organic material collections.

All participants felt there were significant barriers to greater participation. This includes a lack of funding for operations, central and local government policy favouring large scale models, resource consenting constraints as well as a lack of awareness within government on how different composting methods and models compare in terms of delivering wider social, environmental and cultural benefits. These barriers combined make it challenging for the organisations interviewed to grow their services and activities. More established organisations also found it challenging to recruit staff with expertise in commercial composting and this was cited as a barrier to growth.

[36] See discussion and definition of ‘decentralised’, ‘community’ and OSMS organisations in Chapter 3 *Localising Organics* of this report.

1 Introduction

1.1 Scope of work

The focus of this study is to understand what role community organisations in the Waikato want to play in the collection and processing of organic material and how they can be enabled to do more. This involved engaging with community organisations who are currently playing a role in the collection and processing of organic material or groups who wish to play a role in the future. More specifically questions focused on understanding participants' current activities, aspirations and challenges in this work or their interest in playing a role in the collection and processing of organics in the future and what this may involve. In addition, the study aims to develop an understanding of participants' current capability and knowledge in the collection and processing of organic material as well as what support and capability development they need to achieve their aspirations.

1.2 Definition of community

Discussion and definition of OSMS clubs and service providers is provided in depth in the Localising Organics chapter of the Circularising Organics project. The interpretation of who to involve in this study as 'community' has been intentionally broad to ensure a range of perspectives were captured. Organisations approached to participate in the research had one or more of the following attributes:

- Are members of the Zero Waste Network – either charitable organisations or community enterprises working in resource recovery;
- Conduct organic material collection and processing activities that are small to medium scale,
- Are enabling organic material to be processed at a household level by providing education and/or technical services.

This engagement did not include individuals who are composting at home or with iwi / hapu.

1.3 Participants

This study involved engaging 19 organisations who:

- are located in the Waikato Region or close to the region and their work crosses into the region (i.e. the Bay of Plenty);
- are active or have a presence in the region but core operations are out of the region;
- have specialist subject matter expertise that is relevant to this project or are playing a significant enabling role;
- do not currently operate in the Waikato but are intending to;
- are social enterprises or who other participants suggest fit under the 'community' umbrella.

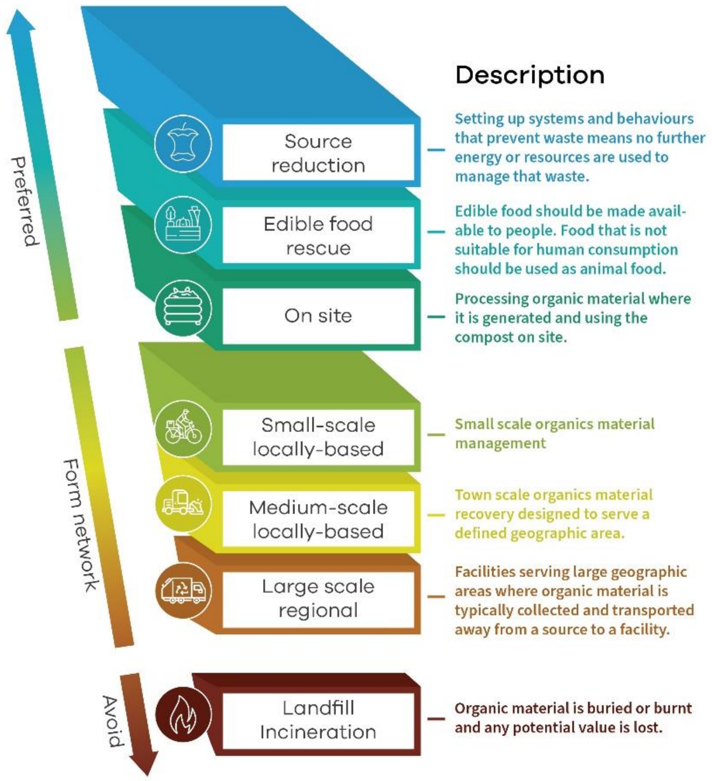


Figure 5 An organic material processing hierarchy

The majority of participants approached are working towards the top of Organic Waste Hierarchy, as described in Figure 1. More specifically, they were engaging in activities focused on Source Reduction, Edible Food Rescue and OSMS. One operator would be considered to be Large Scale Regional due to the volume of organic waste collected and processed in a number of regions. The majority were been operating for 5+ years with seven being very experienced (operating 10+ years). The image below provides an overview of the structure, activities and experience of participating organisations.

Figure 3 Profile of participating organisation interviewees

2 Methodology

2.1 Research approach

A qualitative research approach was used to develop an understanding of what role community organisations in the Waikato want to play in the collection and processing of organics and how they can be enabled to do more. This involved one to one or small group discussions as well as a larger group hui/workshop. Where possible, interviews were conducted online to minimise costs and emissions. Most interviews were an hour long with some follow up required from participants to review notes and summary produced during the interview to ensure accuracy and enable any additional information to be included.

All participants from community organisations or social enterprises were offered koha as an acknowledgement of their time and expertise. This was well received by participants who are often asked to participate in community consultation on top of an already heavy workload due to being under-resourced and/or in a volunteer or part time capacity.

The interview questions can be found in Appendix A, page 189.

3 Findings

3.1 Community profile

There's an active and passionate community already involved in OSMS collections and processing of organic waste in the Waikato (and close surrounds) who enthusiastically supported this research and were keen to participate in it. Most of those interviewed operate at the top of the organic waste hierarchy. Many saw the work they do in the collection and processing of organics as a vehicle to change the hearts and minds of citizens on the value and opportunity of organic material.

All organisations are purpose driven with shared aspirations for a healthy planet and all species that depend upon it. Creating localised circular systems for organic materials was cited as key to food security and sovereignty for communities, building healthier soils, reducing greenhouse gas emissions, contributing to economic development and overall resilience for the region. Most participants felt that delivering their activities (i.e. food rescue, organic material collections and/or processing) was an opportunity to connect with communities and enable conversations that have the potential to deliver long term behaviour change.

Enabling behaviour change was an important driver for many organisations with this work either embedded into delivery models of organisations or additional work programmes delivered (i.e. education workshops delivered, content and resources delivered through newsletters or social media). However, most of this work is delivered voluntarily as funding for source reduction work is currently limited. Given many organisations are already undertaking this work, resourcing them to do more is likely to deliver positive outcomes and a good use of resources given these organisations are widely connected and trusted voices in their communities.

3.2 Methods

Vermicomposting and hot composting were the key methods used by participants. The types of systems used varied, however, most small-scale locally-based operations were using the hot composting system provided by the Carbon Cycle Company. Most organisations using this system were pleased with it and received support from the company for the installation and in some cases, ongoing support to manage the system.

Several participants felt strongly that using anaerobic digestion (AD) to process food waste / produce energy wasn't always the best use of these resources. More specifically, food scraps and garden waste is needed to create soil products that will regenerate soil and grow food locally. Several participants felt that education was needed for decision makers on the advantages and disadvantages of using AD when compared against other methods such as composting for garden and food scraps and the need to prioritise processing material locally.

3.3 Localised networks and scale

Most held the view that a localised network was a critical part of enabling food security and sovereignty while regenerating the natural environment. Moreover, building a localised model should be a core focus and that it will likely be necessary to integrate this with a kerbside collection or other facility / model. The key point raised was that achieving positive social, environmental, cultural and economic outcomes should underpin the development of any model for the region.

A number of organisations believe that scale can be achieved through a localised model that employs a range of collecting and processing methods / locations to compost organic material. Respondents had a concern that the current approach for local authorities to contract a private waste company collect material across a town/city and process material at a distant location wasn't ideal and there are other models that reduce emissions and are more circular. Notably, more mature organisations felt that a localised model would need to be integrated with a kerbside organics collection service and large scale facility as part of the model. More research would be needed to develop an integrated model, however, achieving positive social, environmental, cultural and economic outcomes should underpin the development of any model for the region.

3.4 Aspirations and barriers

3.4.1 Most organisations have aspirations to scale but face barriers

Most organisations are currently scaling operations or have aspirations to do so. However, they face a number of barriers to growing operations and impact and require support. One mature and very experienced organisation felt strongly that businesses are currently an underserved market and that providing a collection and processing service to them was an opportunity for community resource recovery organisations.

The type of support needed by participating organisations depended on the breadth of services delivered and tenure of the organisation. Key barriers are communicated below.

3.4.2 Lack of sector expertise

Mature organisations operating medium scale or large scale regional services cited a gap in commercial composting expertise generally. They shared that the lack of talent and expertise was a hindrance to growth and they were either starting to develop their own education programmes or were intending to do so. These organisations also felt that the lack of career opportunities and pathways in the sector also presented challenges to attracting and retaining talent.

3.4.3 Limitations from current policy

Several organisations felt that central government policy and the Waste Minimisation and Innovation Fund priorities were focused on supporting centralised and large-scale facilities making it challenging for small and medium sized organisations to play a greater role. Several organisations felt that current central government policy was lacking vision to support models that enabled the most favourable social, environmental and cultural outcomes for society for now and well into the future.

3.4.4 Lack of funding for operations

Funding for operations was mentioned by almost all organisations as a barrier to growing activity. Some participants mentioned that funding for infrastructure was accessible and welcomed more of this, however, having more capacity in the form of paid staff (and expertise to build capability) is needed in order to grow their operations.

3.4.5 Lack of knowledge and cohesion between central and local government

Several organisations felt that local and central government operate in silos and there is a need for cohesion between the two to enable more community involvement in localised composting activities and for operating organisations to play a greater role. They felt there is a lack of awareness and knowledge within local and central government on the advantages and disadvantages of different composting methods (i.e. aerobic composting versus anaerobic digestion versus pyrolysis (specifically to create Biochar) etc) and felt upskilling would enable more effective decision making. Moreover, they felt that an increased understanding of social and community enterprise business models would aid in decision making. Staff churn within local government was also cited as a challenge by participants.

3.5 Leveraging existing networks

Existing networks such as schools, community resource recovery centres and community centres are an untapped resource and could be part of a composting network. Schools that operate within the EnviroSchools programme are well positioned to do more in collecting, receiving or processing organics as well as using the output to grow food onsite. Schools generally present an opportunity to become part of a network as they are natural hubs in the community with many having access to land.

Some Community Centres are currently receiving and processing small volumes of organic material from local schools or other parts of the community. This activity is currently small-scale, however community centres are hubs and anchor organisations in the community and could be mobilised to do more. They would require funding to build capacity and capability, however, similar to schools have access to land and are anchor organisations.

Similarly, community resource recovery organisations across the region could become part of a regional or national composting network. There are at least three mature community resource recovery centres in the region who are active in this work as well as a number of smaller or emerging organisations that could become part of a network. Two of these organisations in the region are particularly experienced, and there is an established network of small scale community resource recovery organisations in the Thames-Coromandel district that have developed a shared vision and are working cohesively to deliver local resource recovery activities.

Several participants felt strongly that community enterprises are an important part of any organics collection and processing network. With over 100 community resource recovery enterprises operating across the country (many already accept food and garden waste) participants felt there is an opportunity to work with this existing network to establish a national and regional organic collection and processing network.

3.6 Regional Circular Economy

Mature organisations identified clear pathways for community involvement. These organisations offered clear ideas of where they see the opportunity for communities to participate in a regional circular economy for organics. Most have significant experience in the collection and/or processing of organics and/or working closely with organisations and businesses doing this work at various scales. Involving these organisations in the next stages of this research would be beneficial.

Several of these organisations are already playing an enabling / community activator role and could do more. For example one participant has a funded Community Activator Role that champions community level composting and provides small grants to groups wanting to play a role or do more in small scale composting.

Another participant operating at a large scale felt that community organisations could be satellite sites that accept organic waste which can then be transported to a larger processing site. This organisation felt that community organisations were well positioned to be part of a regional network approach given many already work in organic material collection or processing (or intend to) have existing networks and are trusted voices in the community.

3.7 Contamination

Contamination wasn't mentioned as a key barrier for most organisations. Most participants are operating at a small to medium scale and work closely with their communities / customers to communicate what is and isn't accepted for processing which could explain this. However, some smaller scale organisations were hesitant to scale up without support as it would make it challenging to control volumes and material without the right support / systems which could lead to contamination.

4 Recommendations

Local and central government could do more to enable community participation in the following areas:

4.1 Regulation & Bylaws

- Review, amend and introduce regulation / bylaws that encourage community participation in the collection and processing of organic material. Example: Kerbside food waste collections will be mandated in the short term which leads to the private waste industry being well positioned to take on the contracts and community groups excluded.
- Make land available and accessible for community organisations to utilise for composting as well as food growing.

4.2 Resource Consenting / Zoning

Remove constraints that prevent composting activity on land where the issues are perceived rather than real. Example: A community organisation was close to securing an agreement with council to compost on a green space located next to a community centre, however, the Parks, Sports and Recreation team considered this operation as a 'commercial activity' and not a 'recreational activity' and therefore it was not permitted on Council land and no further discussion possible.
Make the resource consent process more accessible, aligned to regional plans and consistent across regions – regulations for composting are currently under disposal to land.

4.3 Council Staff Recruitment & Education

Employ council staff that are passionate and knowledgeable in sustainability as well as upskill in the following areas:

- Improve understanding on the problems with the current system and the benefits of composting (i.e. building soil, restoring carbon, growing food, cooling the climate etc) and how this compares with industrial models such as Anaerobic Digestion. Having the right staff is key to enabling community participation and enabling approaches that bring the most benefit to society.
- Understand the benefits and opportunities for a localised model and how this compares with centralised systems.
- Address perception issues in relation to how much space is needed to compost / grow food through education – this can be helped with staff being encouraged to visit operating sites.

4.4 Procurement, Contracts & Funding

- Provide funding for operations as well as capital expenditure (i.e. infrastructure).
- Sustainable procurement strategies (i.e. contracts and procurement strategies that are geared towards localised / decentralised models as well as community / social enterprise structures).
- Enable skill sharing/mentoring via the Zero Waste Network to develop a medium sized community enterprise resource recovery programme that will include providing organic collection and/or processing services.

4.5 Education Strategy

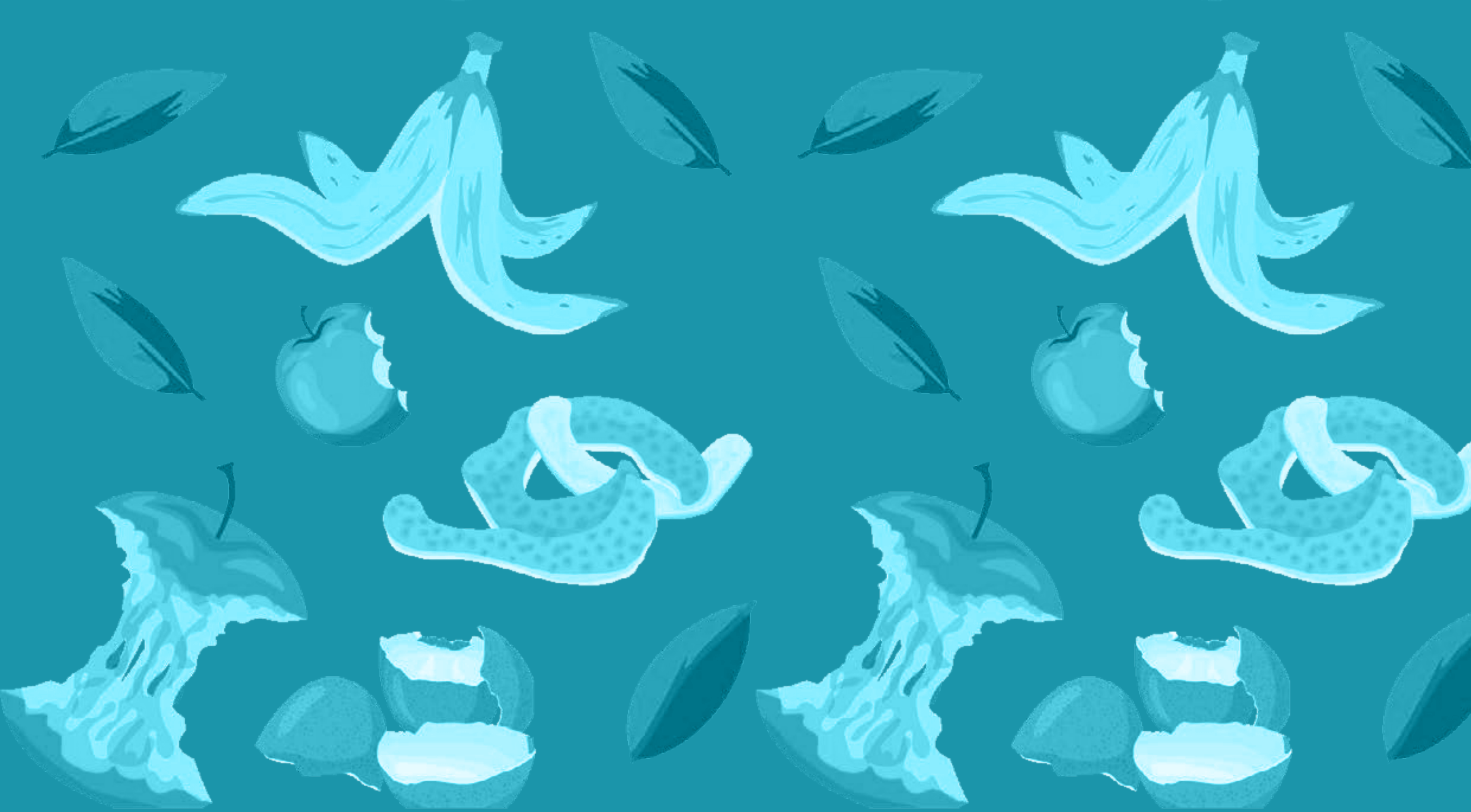
- Build staff capability in commercial composting as this is currently lacking. This is evidenced by large and medium sized organisations establishing their own staff training programmes for commercial composting and highlights absence in academia in this area. The lack of skills in this area was cited as a barrier by several other participants.
- Develop a strategy that has schools as a key part of a decentralised network of composting and food growing hubs.

5 Conclusion

There is an exciting opportunity to further mobilise community organisations as part of a regional organic material collection and processing network. Participating organisations are already playing a role in the collection and/or processing of organics (mostly at the OSMS) and many have aspirations to scale. They are knowledgeable and passionate about being part of a regional model / network. They are also part of existing networks that could also play a role in a regional approach if work is undertaken to remove the barriers discussed above. Participating organisations would welcome the opportunity to be part of a work programme to further develop the concept of developing a regional model for organics in the Waikato.

Appendix A – Interview Questions

- Tell me about the work of your organisation and specifically what work you're currently doing in the collection and processing of organics?
- What systems or methods are you using to do your work?
- What is the impact of this work, what are your aspirations and why is this important?
- What do you see as the current opportunities and barriers for your organisation in achieving your aspirations?
- What is your vision for the role of community in a circular model for organics in the Waikato?
- Where do you think the community will have the greatest impact?
- What support would be useful to your work in the short / medium term.



Chapter 6

Exploring Te Ao Maaori perspectives and market opportunities of circularising organics

Tamoko Ormsby
Whetū Consultancy Group

Amy Whetu
Whetū Consultancy Group

November 2023

Explores culturally appropriate decision-making considerations and opportunities for iwi, Maaori and community. With data support from other areas of the project, the purpose of this report is to generate a study on the potential business/employment opportunities for iwi/Māori business.

Contents of Chapter 6

Executive Summary

This report was commissioned by the Waikato Regional Council as part of the Circularising Organics project to consider a te ao Maaori perspective within the project. It offers a comprehensive analysis, findings, and strategic recommendations for integrating Maaori perspectives and practices in organics circularisation within Aotearoa New Zealand.

The exploration emphasises and analyses the importance of understanding Maaori demographics, attributes, and capital to tailor opportunities in the organics sector that align with Maaori values, business dynamics, and environmental stewardship principles.

The report underscores potential market opportunities within the organics waste sector, propelled by increasing landfill costs, growing public awareness, and the demand for organic compost. It advocates for a holistic approach in evaluating these opportunities against whakapapa-centered criteria to ensure their cultural appropriateness and potential benefits to Maaori communities.

The evaluation leads to tailored recommendations for community-scale composting or vermicomposting as a preferred opportunity that aligns with Maaori perspectives and considerations explored in the report. This is followed by opportunities in small-scale anaerobic digestion, small-scale stockfeed production, and industrial composting as viable options for Maaori uptake and exploration.

In conclusion, the report highlights the critical role of integrating Maaori perspectives with contemporary waste management practices to foster sustainable development in the organics sector. It provides a roadmap for Maaori communities to leverage their unique strengths and values in creating environmentally sustainable and culturally aligned organics processing ventures.

1 Overview

This report has been prepared for the Waikato Regional Council as part of the Circularising Organics project, offering a comprehensive exploration of circularising organics in Aotearoa New Zealand, with a specific focus on Maaori engagement.

The introduction sets the project's context, emphasising key areas like eliminating contaminants in compost, understanding compost end markets, and exploring collection and processing options. It highlights the importance of including Maaori perspectives in decision-making and seeks opportunities for iwi Maaori and community involvement in the organics value chain.

In the analysis section, various groups within Maaori communities are discussed, including businesses, iwi, community groups, and organisations associated with marae and hapuu. This section delves into Maaori business composition, strengths, challenges, and decision-making dynamics, underlining the significance of considering these factors when identifying and assessing opportunities.

The report also examines market opportunities in the organic waste sector in the market context section, taking into account the preliminary work done by the broader project team. It highlights the growing opportunities in this sector driven by factors such as increasing landfill costs, growing public awareness, and the demand for organic compost.

The evaluation section establishes a two-step process to test opportunities against whakapapa-centered decision-making criteria and assess their relevance for specific Maaori groups. It explores how unique attributes of Maaori businesses might impact the success of these opportunities. Furthermore, the report offers tailored opportunities for iwi/hapuu, marae, whaanau, and businesses in the recommendations section. These include options such as community composting or vermicomposting, small-scale anaerobic digestion, small-scale stockfeed production, and industrial composting.

Each section of the report contributes to a comprehensive understanding of the potential for circularising organics in Aotearoa New Zealand, particularly from a Maaori perspective. The report marks a significant milestone in integrating traditional knowledge and contemporary practices to promote sustainable development in the organics sector.

2 Introduction

The "Circularising Organics Project" delivered by the Waikato Regional Council is an MfE funded project and includes a number of collaborative parties, analysing the local value chain of organic waste to provide a pathway for a robust circular loop within the Waikato region.

The overarching project specifically focuses on three primary areas:

- **Focus Area 1** - Eliminating contaminants in compost
- **Focus Area 2** - Understanding the end market for compost
- **Focus Area 3** - Collections and processing options

As part of a holistic view of how to circularise organics in Aotearoa New Zealand, this aspect of the project explores culturally appropriate decision-making considerations and opportunities for iwi, Maaori and community. With support from other areas of the project, the purpose of this report is to generate a study on the potential business/employment opportunities for lwi/Maaori business.

During planning phases of this project, it was identified that the resulting opportunities may be of interest to Maaori. As such, producing outputs that support Maaori decision making processes, has been a clear focus throughout the project. In this context, an analysis of specific Maaori contexts and priorities as well as barriers, is important to support decision making. Hence, this report has been structured to support Maaori decision-making regarding the opportunities identified within the organics value chain in the Waikato region.

This report continues from a preliminary analysis document “Concepts discussion for whakapapa-centred transformation of local economies through organic waste processing across Waikato.” This document provided a framework for discussion regarding the considerations of organic waste for Maaori. This report will continue from this foundation, as well as expand on other works produced by the wider project team, to include considerations of how the preliminary research may inform and provide strategic opportunity for identified Maaori organisations/businesses in the emerging market opportunities identified.

The report includes:

- **Analysis:** Understanding the diverse groups that make up “Maaori” ranging from businesses, iwi, community groups, to organisations lead by marae and hapuu. This includes an analysis of the composition and spectrum of Maaori businesses including the distinct characteristics of Maaori businesses, both strengths and challenges, especially those related to whaanau dynamics and employment decision-making.

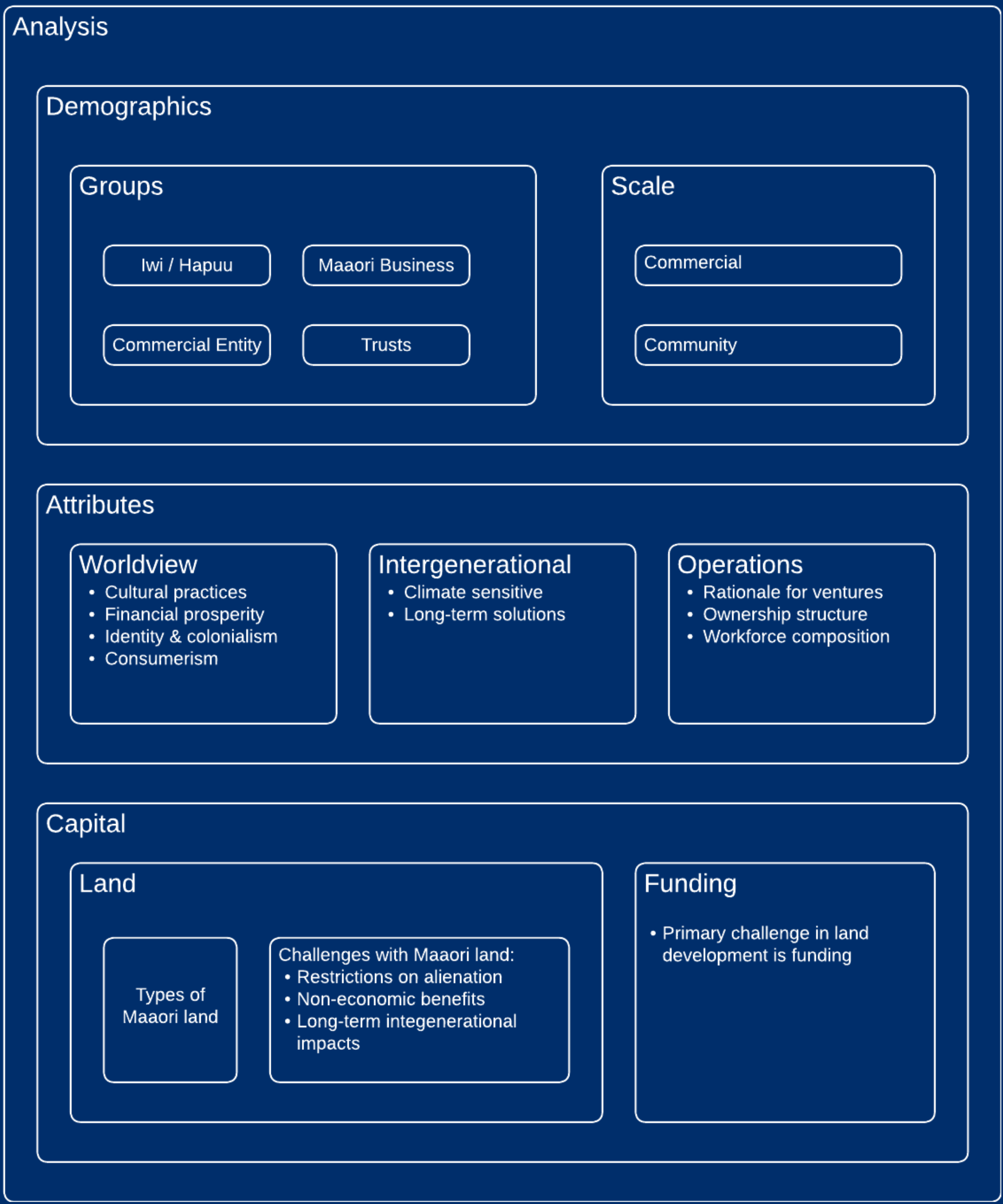
- **Market Context:** A review of market opportunities across emerging markets and after engagement with existing industries in the region based on preliminary work undertaken by the wider project team.

- **Evaluation:** A two-step process was established to:
  - Test opportunities against whakapapa-centred decision-making criteria.
  - Determine the relevance of these opportunities for specific Maaori groups and assess how unique Maaori business attributes might influence the success of these opportunities.

- **Recommendations:** A table of opportunities tailored for iwi/hapuu, marae, whaanau, and businesses is provided.

- **Limitations:** The report acknowledges its scope and limitations, emphasising that it doesn't represent the sole Maaori perspective or any specific iwi, hapuu, or whaanau across Aotearoa. Data limitations, especially regarding Maaori businesses, required reliance on a blend of qualitative and quantitative data, literature, and desktop research. The literature review highlighted inconsistencies in data classification, making industry-specific data extraction challenging.

Analysis



Analysis
Demographics
Groups
Iwi / Hapuu
Maaori Business
Commercial Entity
Trusts
Scale
Commercial
Community
Attributes
Worldview
• Cultural practices
• Financial prosperity
• Identity & colonialism
• Consumerism
Intergenerational
• Climate sensitive
• Long-term solutions
Operations
• Rationale for ventures
• Ownership structure
• Workforce composition
Capital
Land
Types of Maaori land
Challenges with Maaori land:
• Restrictions on alienation
• Non-economic benefits
• Long-term integenerational impacts
Funding
• Primary challenge in land development is funding

This section details the various elements to primarily consider prior to the evaluation of opportunities for Maaori. There are a number of contextual and situational factors that need to be considered when thinking about whether a business opportunity may be viable for Maaori entities. Some of these factors differ and mean that an opportunity perhaps considered viable for some business arrangements may not be when we consider these contexts. Due to the internal and external influences for Maaori, often due to their organisational set up or operating entity, we needed to consider the various attributes for Maaori across the spectrum.

3 Analysis

3.1 Demographics

The consideration of who Maaori are represented by in this space is explored in this broad demographic analysis of Maaori organisations. This ensures the appropriate consideration of options for each group. This part of the analysis has included the following groupings in order to provide consideration of opportunities with a wide Maaori lens: iwi/hapuu, Maaori commercial entities, whaanau trusts/collective landholders, and private Maaori-owned organisations. These groups have then been considered in the context of business operations to validly consider the opportunities posed.

3.1.1 Groups

Iwi & hapuu
In this context, iwi & hapuu are the owners/kaitiaki of assets and also integral decision makers for some commercial entities; they are Maaori collectives or natural groupings. For the purpose of recognising ownership of land, some have been required to establish Post Settlement Governance Entities (PSGE's) as organisations that receive and administer land and other assets resulting from Treaty settlements or through direct acquisition.

Maaori commercial entities
These are the entities that operate commercial interests on behalf of iwi, hapuu or other post settlement governance entities. They are the frontline of business operations and decision making at management level. Some larger entities have their own governance board, others are governed by the board of their PSGE.

The majority of the businesses owned within this space are known to be 'Maaori businesses.' Maaori commercial entities and iwi/hapuu organisations are often seen as interchangeable but they have clearly defined roles and purposes within this space.

Whaanau Trusts or Collective Landholders
These are collective landholders or shareholders of parcels of land mostly held under Te Ture Whenua Maaori Act 1993. These entities are normally whaanau connected groups that operate outside of iwi or hapuu settlement contexts, to utilise their land for the benefit of their greater whaanau, albeit within the confines or restrictions of Te Ture Whenua Maaori Act. These may not feature within Maaori business data and are often missed when considering opportunities that may present for Maaori. They are not operated like traditional businesses unless a business operation is taking place on or connected with the land.

Tangata - Maaori owned Private Businesses
These are private businesses that will be operating independently of PSGE's and other Maaori organisations. Essentially, they are business owners who identify as being Maaori. These are defined in a number of different ways but with standard definitions for government or statutory purposes, normally this is defined as minimum 50% shareholders having Maaori whakapapa. Many of these businesses appear to have been overlooked in traditional data gathering for statistical purposes when considering the Maaori economy. They contribute to a significant and growing part of the Maaori economy.

3.1.2 Scale

The scale of operation for each of these Maaori groups inherently influences the magnitude and nature of business opportunities presented to them. Iwi & hapuu tend to be better positioned to engage in larger-scale ventures and stronger Te Tiriti based obligations from local and territorial authorities. Maaori commercial entities, being at the forefront of business operations, can leverage their commercial expertise to tap into diverse markets, including global markets, potentially scaling up or down based on the resources and guidance from their governing boards.

Whaanau Trusts or Collective Landholders, operating primarily at a local scale, might find niche or larger scale opportunities that cater to the specific needs and aspirations of their whaanau, focusing on sustainable and community-centric ventures. Many collectives have effectively scaled their operations to achieve necessary efficiencies. Private Maaori-owned businesses, being independent and agile, can adapt quickly to market changes, capitalising on both large and small-scale opportunities, depending all standard market factors, and capacity constraints.

In summary, there is a capacity for Maaori organisations to enter into larger scale opportunities if the conditions are right, and it is aligned with the organisation's values and direction, both commercially and culturally.

3.2 Attributes

This point of consideration looks at what makes Maaori businesses unique.

3.2.1 Worldview

The Maaori worldview provides a unique perspective that is shaped by a complex interplay of historical and contemporary factors, including traditional practices, the impacts of colonialism, the shift from cultural to commercial leadership, the influence of consumerism, and the introduction of new contaminants. This context is a prerequisite for understanding, developing and evaluating effective and sustainable opportunities.

Contemporary practices vs. traditional practices:
Traditional Maaori practices were deeply rooted in respect for the environment, with a focus on sustainable use of resources. Contemporary practices, influenced by modern societal norms and technologies, often diverge from these principles. Understanding this shift is crucial to addressing environmental challenges from a Maaori perspective and in turn identifying relevant business opportunities.

Commercial and financial prosperity:
Cultural leadership within Maaori communities traditionally emphasised the protection of the environment and the principle of mana. Commercial leadership, often driven by profit motives that may necessitate the financial well-being of communities or iwi, may be in a position that requires

they prioritise short-term gains over long-term environmental health. Recognising these differing priorities can help in developing strategies and opportunities that balance economic development with environmental stewardship.

The impacts of colonialism on cultural identity:
The impacts of colonialism and colonisation on Maaori are well researched. These have impacted cultural identity and language, disrupted the transmission of traditional intergenerational practices and introduced new ways of interacting with the environment. Acknowledging these impacts is essential to understanding Maaori perspectives on environmental issues and the context from which Maaori are operating within, and thus how an opportunity might be viewed by Maaori.

The role of consumerism in shaping behaviour:
Consumerism, a byproduct of modern society, has influenced behaviour, often promoting consumption patterns that lead to increased pollution and environmental degradation. Understanding this influence is important when considering Maaori perspectives on these opportunities, as it highlights the tension between modern lifestyles and traditional values of environmental respect and sustainability.

3.2.2 Intergenerational

Maaori perspectives are entrenched in a deep commitment to future generations through intergenerational decision making. This is based on an enduring relationship with the whenua and the role of humans as kaitiaki. This foundation aligns well for businesses planning for opportunities with long-term horizons that are still considered by many to be far out of traditional business horizons, including those in the waste and organics sector.

As with many others, Maaori businesses and organisations are still struggling with the same complexities, operating in the current environment and the realities of shorter-term planning and solutions. In addition to this reasoning, the more sizable nature of iwi and hapuu commercial investments and resourcing make this intergenerational planning more prevalent and a bigger expectation for iwi and hapuu commercial enterprises.

More than 50% of the Maaori asset base has been assessed as being in climate sensitive primary industries including forestry, fisheries, agriculture and to some extent tourism. Due to these sensitivities, the future for Maaori businesses necessitates the need to adapt and transition into business opportunities that are less exposed to climate sensitivities and utilise the identified asset base through emerging and increasing potential markets, such as that of waste and the organics sector.

Maaori businesses are often at the forefront of innovation and technological advancements and can transition into this further where these opportunities align so clearly with Maaori and iwi/hapuu aspirations for te taiao. The baseline for considering the relevance of the opportunities within this project for Maaori, rests with the interconnectedness of Maaori with te taiao.

3.2.3 Operation

Rationale
A 2020 report by BDO indicates that the primary ‘purpose’ for businesses within the Maaori sector were cultural, social, & environmental outcomes; profit to drive purpose; employment; and asset growth (BDO 2020). Their 2023 Maaori Business Sector Report echoes these findings. The operating rationale for many Maaori businesses underpin decision making and are considered akin to economic KPIs within the business realm. In the context of Maaori commercial entities operated by

iwi and hapuu PSGE, their commercial entities are guided by vision and purpose that is centred primarily on increasing the wellbeing of te taiao and te tangata. These PSGEs collectively uphold these expectations on behalf of their people and provide oversight and budget to ensure these priorities are upheld.

According to the BDO (2020) report; the keys to success for achieving their purpose in the sector included happiness and whanau wellbeing; financial performance; and cultural wellbeing. Both the purposes identified and the keys to achieving them acknowledge the role that profit plays, and the reality is that Maaori commercial entities are still focused on achieving profit for their tribal member's benefit, similar to other corporates driven by shareholder returns. The difference lies in the direct link between the use of those funds for wellbeing of the collective, (with most parent entities being Charitable Trusts or Incorporated Societies driven by charitable purposes) rather than the personal gains of individuals.

Ownership
For Maaori businesses owned collectively by iwi and hapuu members, any impacts on these businesses are immediately amplified by virtue of the number of people that are relying on or supported by that business' success. This is to some extent magnified within Maaori owned SMEs who also have been found to operate under similar values-based rationale (TPK, Te Matapaeroa, 2019).

Each iwi and hapuu collective, Maaori business and individuals have their own identified aspirations. These value baselines equate to increasing impacts when a business or commercial enterprise faces financial hardship or is forced to pivot without forethought or planning. This is not only true for Maaori commercial entities; it also influences many private Maaori operations who through the influence or visibility of these expectations of their iwi, or their own aspirations, seek to uphold the key tenets of kaupapa and tikanga Maaori. Principles of manaakitanga, whanaungatanga, kaitiakitanga and kotahitanga for example, often guide Maaori business operations.

3.3 Capital

A third factor of the analysis is that of capital.

3.3.1 Land

Defining Maaori land is relevant in assessing the adaptive capacity and vulnerability within this context and impacts heavily on the ability for these entities to pursue opportunities at the same pace as non-Maaori businesses/landowners.

This involves identifying the differences between land ownership and structures, and the nuances of these that change the way land is able to be used. It also involves identifying the way and speed with which any changes are likely to be made in relation to any Maaori businesses operating on these types of land, or within these types of structures.

Although Maaori land includes individually or collectively owned general land, many Maaori are working on, or with, land and making decisions around land that is owned under Te Ture Whenua Maaori (Maaori Land Act) 1993 (TTWMA). This act defines the types of ownership structures (Journeaux et al, 2017) that can govern and own Maaori land and therefore this influences land use. These entities are defined under the act as shown in the table.

Types of Maaori Land	
Ahuwhenua Trust	Designed to manage blocks of multiple owned Maaori land and are the most common structure used by Maaori landowners.
Maaori Incorporation	A body corporate with perpetual succession and with powers which, in form and basic structure, are similar to the joint stock company.
Whenua Toopuu Trusts	These trusts are similar to the Ahu Whenua trust in that its structure is designed to manage the entirety or major proportion of a tribal estate. It differs in one aspect however, in that the individual's land-owning interests are not maintained.
Whaanau Trusts	Trusts used by whaanau to halt the fragmentation of share interests. The Whaanau Trust holds the interests in the land and additional members are added to the list of owners without receiving individual interests

(Adapted from Journeaux et al, 2017)

3.3.1.1 Challenges with Maaori land capital

The challenges that such land ownership sometimes presents are not insignificant. The ownership structures of Ahuwhenua Trusts, Maaori Incorporations, Whenua Toopuu Trusts and Whaanau Trusts each have some constraints, and these should be considered in the context of Maaori land ownership, Maaori businesses and decision making, land use changes (Reid et al, 2013).

Although there is the ability to operate as a more commercially oriented structure (such as Ahu Whenua Trusts and Maaori Incorporations) there are still a number of barriers that need to be considered when compared with operating a business operation for non-Maaori. The way these elements impact decision-making on Maaori land is what makes these processes different from general individuals or organisational land/business owners in at least three important ways:

- **Restrictions on alienation** (sale) limit the use of assets from being used as collateral, limiting owners' access to credit; inability to borrow against collectively owned land from traditional (read lower interest) institutions thereby limits uptake, choices for transition and the ability to take up new and emerging technologies.
- **Non-economic benefits**, such as access to traditional medicines, hunting, providing social welfare, and maintaining a cultural connection to the land, are sources of value, in addition to economic returns; this foundational perspective and desire to retain ownership, derive non-economic value and connection to lands, makes decision making considerably more complex for Maaori.
- **Long-term, intergenerational impacts** receive consideration in most decisions. These differences all stem from cultural values applied to resource allocation decisions (Funk, 2009). It could be argued that both TTWMA and proposed climate change policy may in fact align with these perspectives in more ways than one.
- Further, acknowledgement of the **spin-off issues around frustrations with limitations of the act and related governance structures**, resulting in often heated and emotional trustee

meetings that are not conducive to timely, effective or focused decision making on major issues that may be required (Dell, 2017).

The context of this research and identification of key issues is important as it significantly changes the responsiveness of Maaori business and landowners to new strategic opportunities by affecting the process of decision-making (Reid, 2013).

However, it does need to be acknowledged that for many larger iwi, land holdings are often held under general freehold title, and often with very effective governance in place.

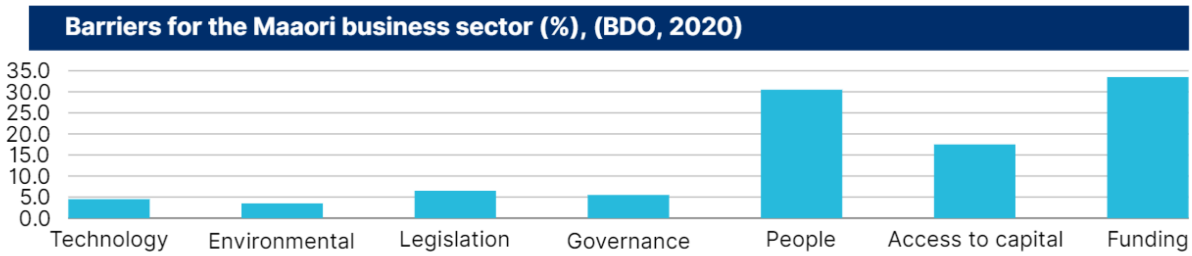
Further, land acquired by iwi directly is not likely to be TTWMA land and therefore some of the restrictions identified do not exist in these instances. Not being able to borrow against assets is also not necessarily an issue where considerable wealth has been accrued and lenders are proactively willing to lend. Smaller trusts and incorporations may be hit harder by these issues and barriers. Their ability to mitigate or navigate their way through them is always more limited due to capital, resources and skill sets.

3.3.2 Funding

As per the BDO Maaori Business Survey Report (2020), research was undertaken regarding the primary challenges that Maaori businesses face across the board. These key metrics are outlined in the table below, with the following top three barriers comprising by far the biggest challenges: Funding (34%), People – capability & capacity (31%) and Access to capital (18%). An inability to access funding and capital is often flagged as the primary challenge in development for Maaori landowners, and further for Maaori business owners, particularly SMEs who experience financial exclusion in far greater numbers than non-Maaori business owners. This may directly result in an inability to resource/fund the identified business opportunities.

Governance remains critical and is highlighted as one of the major factors of influence for vulnerability (MfE, 2019). For Maaori entities this continues to remain a challenge, with larger and sometimes less suited governance arrangements existing due to the legislative requirements of managing post settlement assets.

Identifying the differences between land ownership and the nuances of these that change the way land is able to be used, and the manner and speed with which opportunities are able/likely to be taken, is important in considering any proposed market opportunities and likely uptake.



Market Opportunities

Market Opportunities

Industry Engagement

Producers

Opportunity: to extract more value from their outputs

Challenges/Barriers: Lack of Capital for better infrastructure, shared resources

Composters

Opportunity: Larger demand from the horticultural industry

Challenges/Barriers: Contaminations, consenting and addressing leachate

Anaerobic Digestion

Opportunity: Potential renewable source of CO_2

Challenges/Barriers: Removal of digestate, and specialist equipment needed

Market Analysis

Vermicompost & Compost

- Increase demand for organic products

Digestate

- AD is one of the simplest biofuel technology

Bark & Woodchip

- Massive growth in Asia-Pacific region

Māori Engagement

Capacity

- Limited capacity to prioritise organic waste processing
- The reliance on key individuals as catalysts to drive initiatives

Process

- Timing the delivery and launch to coincide with iwi milestones
- Obtaining mandate and approval from the right people at iwi/marae levels
- Finding a site

Capability

- The potential to establish a support network for Maaori operators
- Build local and whaanau capability
- Establishing whaanau operating levels
- Understanding the risks of contaminated inputs

4 Market Opportunities

The greater project included a review of market opportunities across emerging markets and after engagement with existing industries in the region (as part of wider project). Tonkin and Taylor were responsible for undertaking a market assessment within the project. Their output included interviews with industry producers and processors and provides a summary of barriers and market opportunities.

The following are key points identified within their project summary:

- The market is expanding. New processors are entering the space, many existing processors are currently establishing or looking for new locations.
- There are general shortages of inputs such as green waste to meet the required demand for compost. Consensus among processors that the combination of public perception, increasing landfilling costs and demand for outputs have resulted in a large opportunity to grow.

Some processors believe they have captured all available and suitable materials within their available area, additional sites are being proposed and developed to cover new areas. A variety of company sizes are also emerging to acquire untapped niches in the market.

4.1 Industry Engagement

4.1.1 Producers

The interviews of 'producers' noted that they were all aware of the need to reduce organic material being sent to landfill or discharged to land and water as part of their environmental performance.

4.1.1.1 Opportunities

The biggest opportunity was identified through most producers not focusing on extracting the maximum value from their outputs, but rather focusing on finding the most convenient options for improving environmental performance. Businesses that have placed a particular focus on keeping organic materials in their highest form of value have successfully converted paying for waste stream removals into revenue streams. Therefore, this has often led to instances of lost opportunity.

4.1.1.2 Barriers & Challenges

There were a number of reasons identified as reasons for this:

- ***Capital***: Smaller producers can lack the capital to purchase processing infrastructure such as dissolved air floatation processing.
- ***Inconsistency***: Resilience is prioritised over extracting value from material as the revenue can be insignificant compared to the overall operation. Examples of sending materials to treatment facilities rather than stockfeed due to the ability to handle shock loads and the inconsistency of feedstock demand.
- ***Collective opportunities***: It was noted that it is a lot easier to establish shared resources across different businesses early on. Notable lost opportunities to develop shared plant resources which have since resulted in producers investing in their own capital.
- ***Lack of expertise***: Lack of expertise when trying to process organic material onsite can lead to missed value from lower quality products. Collaboration with processors is typically limited to trucking material to their site.

- ***Long-term viability***: Long term agreements with end markets are required before capital can be invested into processing outputs into more valuable forms.
- ***Joint ventures***: Partnerships with third party processors is occurring but is not common despite multiple opportunities for JVs available. Flexible options for JVs to suit the needs of the producer, can have onsite operations or arrange collection. Many of the processors are actively looking to work with more producers.
- ***Limited options***: Limited biodegradable or separatable options for fixings within the horticultural industry, leads to contamination of outputs or the requirement for landfilling organics. This is a known issue which is being worked on.

4.1.2 Compost and Vermicompost

Interviews with the industry identified that there are shortages of large-scale inputs to meet the current demand for output (both compost and vermicompost). The brilliance of vermicomposting lies in the capability to process virtually all organic material streams. In return that means the logistics of providing this service where needed within proximity to input production results in logistical difficulties.

Ash, waste activated sludge, dissolved air flotation sludge, biosolids and manure are some examples of typically problematic material streams which can be handled by vermicomposting, which presents significant opportunities. Further, systems such as composting and vermicomposting can be complementary to improve resilience to feedstock shortages and shock loads.

Processing time can range from 12 weeks to 12 months depending on processing methods and maturing time. Each site is designed alongside parameters such as the available space, capex for infrastructure and proximity to people. Discussions around contamination were met with a variety of opinions. Large plastics and other contaminants were noted to being able to be screened out at the final stage. By working with organic material suppliers' input contamination can be reduced.

4.1.2.1 Opportunities

The opportunities identified through conversations with processors were many but varied based on a number of factors.

- ***Demand from horticulture industry***: Wide range of value for the outputs depending on inputs, levels of contaminants and if value adding additions or processing occurs. Larger demand for outputs is also seen by the horticulture industry than agriculture, perceived by some to be due to horticulturists having a higher appreciation for soil structure. There is also a shortage of outputs to meet current market demand.

4.1.2.2 Barriers & Challenges

- ***Contaminants***: There was an awareness of regular examples of contamination which inhibit the value of outputs; progress can be slow to remove them (PLA, PFAS in biodegradable food ware, orchard plastics, sprays and herbicides). Some do not believe contamination is much of an issue due to screening for physical contaminants, testing for chemical residue, and the fact that it is rather unavoidable. However, it was noted that there was a significant decrease in contamination after single use bags were banned. Removal of contaminants would result in a more valuable product, however may require broader regulation.
- ***Consenting***: Gaining resource consent was largely seen as the most prominent hurdle faced by businesses looking to expand their operations. Much of this is due to perceived shortages in skilled workforce amongst council and iwi. Suggested there may be an opportunity to improve this for vermicomposting by developing a standardised application procedure

(similar to composting) for a currently unique application. This would be supported by the track record which the companies are beginning to establish.

- ***Addressing leachate:*** Some believe the issue of leachate can be solved by rotating windrow sites, investing in capital and correctly balancing the mixture of material inputs.

4.1.3 Anaerobic Digestion

When interviewed, the processors of anaerobic digestion facilities identified, had capacity of between 75,000t/yr and expanding to 100,000t/yr. They processed waste from households, supermarkets, grease and dairy but did not accept abattoir waste. Their systems utilised return transport from other businesses on their return route, reducing transportation costs and environmental footprint. Those interviewed indicated a preference for fat over carbohydrate and protein products due to a higher gas yield produced. They also identified that they do not undertake any de-watering due to the inability to identify a return on such an investment in the facility.

Those interviewed indicated key factors regarding their outputs to be:

- Approximately 100,000GJ of gas exported to the network annually - after onsite power and supply to neighbouring tomato greenhouses is extracted.
- Approximately 60,000t of digestate is produced annually, which is spread on surrounding farms (approximately 1,200ha – 1,500ha).

4.1.3.1 Opportunities

- ***Renewable source of biogas***: The primary opportunity is the ability to generate a potentially renewable replacement for a renewable source of CO2 which can be used in greenhouses and the food industry.

4.1.3.2 Barriers & Challenges

- ***Removal of digestate***: The largest barrier is the continual removal of digestate. For every 200t of input there is approximately 185t of output. New Zealand currently allows irrigation during winter; however this is banned in some places overseas due to leaching potential. This therefore poses a big issue for the industry, should regulations change. Aiming to get the digestate certified as a biofertiliser may reduce the restrictions on application to land.
- ***Specialist equipment***: Specialised equipment required for application of digestate to apply it close to the ground and reduce it volatising.

4.2 Market Analysis

Further work should be undertaken regarding the size of the likely national and regional market opportunities for each of these priority markets. With a high level review of global indicators for growth clear trends are visible. We have focused on the opportunities where we feel there is alignment with the above identified areas of interest for Maaori.

4.2.1 Compost and Vermicompost

Research indicates that this market is expected to see growth of 6.5% to 2027, reaching a market of up to $9.51Bn globally, based on increasing demand for organic farm products. With the Asia-Pacific region being the largest predicted market. Although the principles of a circular economy can be prioritised clearly through product creation and systems approaches, Aotearoa’s physical proximity to market also makes export an opportunity when looking at return on investment and opportunities for larger scale production moving forward (Business Research Company, 2023).

The Vermicompost market offers a higher predicted growth rate based on significant growth over the past few years. With the Global Vermicompost Market valued at US$63.55 Million in 2019, this is projected to reach US$222.42 Million by 2027, growing at 16.74% from 2020 to 2027 (Verified Market Research, 2023).

4.2.2 Digestate

Global anaerobic digestion market according to a new report of Fairfield Market Research will reach the revenue worth over US$18.5 Bn by the end of 2026. Between the years of forecast 2021 and 2026, the anaerobic digestion market is expected to exhibit 17.7% growth (Fairfield Consulting, 2021). As one of the simplest proven bio-fuel technologies, anaerobic digestion presents the opportunity to represent a significant proportion of the the expected biofuel market growth over the coming decade, from US$75 billion in 2023 to a predicted US$138 billion in 2033 (Future Market Insights 2023).

4.2.3 Bark and Wood Chip

The Global Wood Chips Market size is expected to grow from US$8.49 billion in 2022 to US$15.48 billion by 2030, during the forecast period (2023-2030) according to Introspective Market Research. This market growth is driven by demand and proffers opportunity in assisting technologies supporting the industry growth. These markets indicate significant growth and based on the assumption that Aotearoa would be following these trends and in many cases, be ahead of the curve as far as green tech and green trends are concerned, indicate significant opportunity for further research and feasibility to be undertaken.

Identifying which are preferable opportunities for Maaori first, will enable this further research to be more focused and provide deeper insights to support any further investment.

4.3 Maaori Engagement

The Maaori engagement summary report discusses the engagement process related to potential business and employment opportunities for iwi/Maaori within the organics space, and summarised key themes discussed. It consists of three main themes:

4.3.1 Capacity

The engagement highlighted the challenges faced by iwi and marae in prioritising organic waste processing above other more critical issues due to limited resources, competing priorities, and the need for support. Pursuing a new venture of organics processing requires time and effort, which is rare and difficult to be prioritised above other more critical issues.

Key issues considered relating to capacity were:

- Limited capacity to prioritise organic waste processing
- The reliance on key individuals as catalysts to drive initiatives

4.3.2 Process

Timing is a crucial factor when proposing composting initiatives at marae, and it should align with the priorities of constituent marae. The engagement suggested a long-term investment approach. It also highlighted the importance of garnering support from collective, marae and community, prior to escalating to seek support from iwi, such as Waikato-Tainui.

Key issues considered relating to process were:

- Timing the delivery and launch to coincide with iwi milestones

- Obtaining mandate and approval from the right people at iwi/marae levels
- Finding a site

4.3.3 Capability

Building local capability in organics processing is essential for iwi and marae contexts. Developing local talent and expertise fosters self-reliance, economic growth, and environmental sustainability. The engagement report also discussed the need for a support network and the challenges of contamination in community composting.

Key issues considered relating to capability were:

- The potential to establish a support network for Maaori operators
- Build local and whaanau capability
- Establishing whaanau operating levels
- Understanding the risks of contaminated inputs

5 Evaluation

Based on the opportunities identified above, the following options below will be considered against te ao Maaori criteria. These opportunities are:

- Compost
- Vermicompost
- Digestate
- Bark & Woodchip
- Stock food

5.1 Whakapapa Centred Transformation

The former part of the project saw the development of an approach for considering the concepts and ideas developed within the greater project. This resulted in the development of a 'Whakapapa-centred transformation of local economies through organic waste processing'. This whakapapa-centred approach provides a framework for considering both recommendations and opportunities identified within the overall project.

5.1.1 The Critical Questions Approach

The framework resulted in the development of a set of key questions to prompt discussion in our evaluation of "culturally-appropriate" solutions for organic waste processing. Similarly, this approach can help with decision-making for those appropriate business opportunities to be considered in a te ao Maaori context.

Based on the information above, and the critical questions for whakapapa-centred transformation, each option will be analysed and assessed to fully understand viability, feasibility and appropriateness of the option.

Key questions for whakapapa-centred analysis

Whakapapa considerations

- What is the whakapapa of the proposed solution?
- Has the solution been developed and implemented overseas?
- What is the state of indigenous representation in the location of origin?
- What is the level of indigenous knowledge in the original solution?
- What was the role of indigenous people in the design, development, and implementation of the solution?

Atua Considerations

- How does this impact Rangi & Papa?
- How does this impact our relationship with atua?
- Does the activity enhance or diminish relationship with atua?

Whenua considerations

- What unique stories of Aotearoa/Maaori/Waikato resonate with the proposed solution?
- What role does this proposed solution play in the ongoing story of Aotearoa/Maaori/Waikato?
- Is this a continuation of the oppression faced by Maaori in Waikato, or does this story hold an upward trajectory for Maaori in Waikato?
- Who are the mana whenua / marae / haukaainga / pou in the space of establishing tikanga?

Tangata considerations

- How are these roopuu actively involved in the proposed solution?
- What are the tikanga that are guiding this solution?
- Assess the Hua Parakore principles against the proposed solution.
- Assess the Matike Mai values against the proposed solution.

6 Discussion

The conclusion drawn from the evaluations highlights the most effective, and transformative organic waste processing opportunities. Each method is carefully considered for its environmental impact, efficiency in waste reduction, and alignment with Maaori practices and perspectives.

6.1 Community-scale composting

Composting and vermicomposting stand out for their close alignment with natural processes, and as such, their strong alignment across the board with the whakapapa-centred perspectives. By breaking down organic matter into nutrient-rich compost, they not only return valuable nutrients to the soil but also improve its structure and fertility. This not only supports plant growth but also contributes to a more vibrant and diverse ecosystem. These opportunities hold deep cultural significance for Maaori where there are mirrors with the natural processes of te taiao.

By delivering these types of initiatives at the community level, there is an added layer of connection of people and place, while bolstering the local food production cycles and maintaining cycles of organic waste processing as close as possible to source. In addition to reducing waste to landfill, and emissions as a result, community composting acts as a catalyst for community action and investment in community infrastructure. This is a foundation for community food crops, and other activities surrounding food sovereignty, circularity and closed-loop local economies.

As discussed in the report, there is a shortage of large-scale inputs to meet current demand for compost and vermicompost output, underscoring the significant opportunity in these methods. Building at the community level may alleviate the stresses at the larger scale. Waikato-Tainui have noted that they will be more likely able to support marae to activate, before activating commercial opportunities.

Finally, building local capability in organics processing, particularly in iwi and marae contexts, is emphasised throughout the report. This includes developing local talent and expertise, fostering self-reliance, economic growth, and environmental sustainability. Community level activations are people powered, and require more people to activate, teach and as a result become capable environmental stewards.

In summary, the evaluation explored and shows that community scale composting and vermicomposting is the most appropriate fit for organics processing for Maaori.

6.2 Small Scale Stockfeed for Animal Use

Involving the transforming of food waste into animal feed, this can be a highly efficient and simple way to repurpose organic waste. By doing so, it significantly reduces the amount of waste ending up in landfills, thereby decreasing greenhouse gas emissions and overall environmental impact.

This practice can also contribute to sustainable animal husbandry by providing a cost-effective and environmentally friendly feed source. However, it requires careful management to ensure the safety and nutritional adequacy of the feed. When implemented on a small scale, it allows for closer monitoring and control, ensuring that the feed meets health standards and does not disrupt ecological balances. It is an action that is accessible to all who have access to livestock, or have connections to one. This approach not only aids in waste reduction but also supports sustainable farming practices.

After to upcycling food, donating food and upstream mitigation of food waste, converting food waste into animal feed keeps the organic materials at their highest form of value, and can be an effective way of managing organic waste.

This activity is immediately accessible to most marae, and is highly likely to be in practice already at most marae; therefore this is an organics process which should already be normalised. In addition, it doesn’t require any additional specialist training or equipment. As the least complex and readily accessible action, it is highly recommended in scenarios with access to livestock.

6.3 Industrial commercial-scale composting

Compost, as discussed already, has many benefits. With the demand for more organic fertilisers, the viability of commercial level operations should be explored by Maaori entities with the capacity to do so. While industrial composting is efficient in waste reduction and contributes to soil health, its industrial nature might not align as closely with sustainable and cultural practices compared to the other methods. It often requires significant energy input and infrastructure, which can have a larger environmental footprint. However, it remains a vital component of waste management strategies, especially in urban areas where large volumes of organic waste need to be managed efficiently. As such, it is recommended after small-scale community level alternatives have been explored.

The challenges of contamination and the importance of removing contaminants to produce a more valuable compost product are noted. This points towards the effectiveness of industrial composting in managing waste while also acknowledging the need for broader regulation to enhance its value. Industrial level composts have the scale to isolate inputs such that contamination is minimised, to ensure higher output quality compost.

6.4 Small-Scale Anaerobic Digestion

Although this method is somewhat more industrialised, it offers a unique approach to managing organic waste. Small-scale anaerobic digestion systems can effectively process various types of organic waste, converting it into biogas – a renewable energy source – and digestate, a nutrient-rich fertiliser. This dual output makes it an attractive option for sustainable waste management. The smaller scale of these systems often means a reduced environmental footprint compared to larger, more industrial setups. They can be integrated into local waste management strategies, providing a localised solution that reduces transport emissions and supports community energy needs. Despite its industrial nature, when implemented on a smaller scale, anaerobic digestion can foster a closer connection to ecological cycles, promoting a more sustainable approach to resource utilisation.

Further, a smaller scale will allow for social and community scale impacts, while maintaining closed loop inputs and outputs. This can build local capability and understanding of the technology.

The anaerobic digestion market is expected to exhibit significant growth, indicating its effectiveness and potential in sustainable waste management. There are however factors to consider when facing the viability of dewatering digestate, and this should be fully explored for each context if exploring small-scale anaerobic digestion. Furthermore, the need for specialist equipment may be restrictive.

Small-scale, community-driven anaerobic digestion is recommended as a neutral activity, that can be a catalyst for education, whiles creating a useful output for local use.

6.5 Bark and Woodchip

Bark and woodchips were not considered among the top options for sustainable waste management in the evaluation for several reasons, primarily due to their reliance on the forestry industry, which poses other environment challenges.

The forestry industry, a primary source of bark and woodchips, may involve practices that can be harmful to the environment. This includes deforestation, which leads to habitat destruction, biodiversity loss, and increased greenhouse gas emissions. Utilising bark and woodchips as a primary waste management strategy would need to consider the environmental impact from the entire value chain.

Despite the environmental concerns, if iwi are operating in the forestry sector, repurposing bark and woodchips could make financial sense. This is because it allows for the maximisation of resources and the generation of revenue from otherwise waste materials. As discussed, there is a growing market for wood chips, with the global market size expected to grow significantly by 2030. This growth presents a financial incentive for iwi forestry operators to engage in the bark and woodchip market.

However, while bark and woodchips present certain financial opportunities, especially for iwi forestry operators, their overall environmental impact, makes them a less favourable option in the context of sustainable waste management. The preference is given to methods that align more closely with environmental sustainability and cultural values.

6.6 Industrial Anaerobic Digestion

Anaerobic Digestion (AD), though recognised as a method for waste management and energy production, presents several challenges that make it a less favourable option, especially when implemented on a large scale.

Large-scale AD systems are inherently industrial in nature. This industrialisation often means reliance on advanced technology, substantial capital investment, and significant infrastructure.

The process of anaerobic digestion generates methane, a potent greenhouse gas. While methane can be captured and used as biogas, any leaks or inefficiencies in the system can contribute to greenhouse gas emissions. The AD process also produces CO2 as a byproduct. Although some of this CO2 can be utilised (e.g., in greenhouses), its production still adds to the overall carbon footprint, and could potentially be released if CO2 absorption levels are reached.

Further, the digestate, a byproduct of the AD process, presents its own challenges. It's often not viable to dewater the digestate effectively, which can limit its usefulness, as discussed by operators in engagement. While dewatered digestate can be used as a fertiliser, the inability to dewater it properly may reduce its applicability in certain agricultural settings, potentially limiting its benefit as a soil amendment.

The inputs into these systems often come from various sources, and the benefits (like biogas or digestate) may not return to the communities that provided the raw materials. This lack of a localised circular economy approach means that the benefits of AD might be more distributed or centralised, rather than directly enhancing the local communities from which the organic waste is sourced.

Lastly large-scale anaerobic digestion systems require a consistent and substantial input of organic waste. Gathering, transporting, and processing this waste can be logistically complex and costly. The economic viability of anaerobic digestion can be a challenge, especially in areas where the necessary infrastructure or market for biogas and digestate is not well-developed.

In summary, while AD offers certain advantages in terms of waste reduction and energy production, its large-scale, industrial nature, along with challenges related to byproducts management, limited local economic benefits, and logistical complexities, make it a less desirable option in the context of sustainable, community-focused waste management strategies.

It could potentially be a viable alternative at less complex, smaller-scale, community-driven levels.

7 Recommendations

Based on the analysis of the options summary the following options are recommended for Maaori, in order:

- Community composting/vermicomposting
- Small-scale stockfeed for animal use
- Industrial composting
- Small-scale anaerobic digestion
- Bark and woodchip
- Industrial Anaerobic Digestion

The options have been chosen based on how well they fit the various criteria and considerations explored throughout this report.

8 Conclusions

This report prepared for the Waikato Regional Council under the Circularising Organics project provides a comprehensive and insightful analysis into the potential for circularising organics in Aotearoa New Zealand.

The report delves into the complexities and potentialities of various Maaori groups ranging from iwi and hapuu to private Maaori-owned businesses, offering an in-depth understanding of their distinct characteristics and the opportunities and challenges they face. The market analysis section highlights the expanding opportunities in the organic waste sector, driven by increasing public awareness, rising costs of landfilling, and growing demand for organic compost.

A significant aspect of the report is its emphasis on the integration of Maaori perspectives and indigenous knowledge in the decision-making and operational processes. These are explored using the whakapapa-centred framework develop earlier in the project. The report finally recommends key actions and the potential for community composting or vermicomposting, small-scale anaerobic digestion, small-scale stockfeed production, and industrial composting as viable options for Maaori involvement.

In conclusion, the report stands as a testament to the importance of integrating traditional knowledge and contemporary practices for sustainable development. It provides strategic insights and recommendations that are culturally sensitive and economically viable, paving the way for Maaori communities to engage effectively in the organics sector. By addressing the unique needs and values of Maaori, the report not only contributes to the circular economy but also fosters the principles of environmental stewardship and cultural integrity.

Appendix A - References

BDO (2020) BDO Māori Business Survey Report 2020 https://www.bdo.nz/getmedia/d756d8ed-759d-4943-8768-915c1cfe1fb7/Maori-Business-Report-2020-FINAL_1.pdf

BDO (2023) BDO MĀORI BUSINESS SECTOR REPORT 2023 https://www.bdo.nz/en-nz/industries/maori-business/maori-business-sector-report

BERL. (2021) Te Ohanga Māori- The Māori Economy. https://berl.co.nz/sites/default/files/2021-01/Te%20%C5%8Changa%20M%C4%81ori%202018.pdf

Dell, K. M., (2017) Te Hokinga ki te Ūkaipō: Disrupted Māori Management Theory Harmonising Whānau Conflict in the Māori Land Trust, University of Auckland Management School Doctoral Thesis.

Fairfield Market Research (2023) https://www.fairfieldmarketresearch.com/report/anaerobic-digestion-ad-market

Funk, J. (2009). Carbon farming on Māori land: Do governance structures matter? MOTU. Retrieved from: https://motu.nz/our-work/environment-and-resources/lurnz/carbon-farming-on-maori-land-do-governance- structures-matter/

Future Market Insights (2023) https://www.futuremarketinsights.com/reports/biogas-market

Global Market Research Stats (2023) https://www.thebusinessresearchcompany.com/report/compost-global-market-report

Introspective Market Research (2023) https://introspectivemarketresearch.com/reports/wood-chips-market/

Journeaux, P., Kingi, T. & West, G. (2017). Mitigating greenhouse gas emissions on Māori farms, an NZAGRC Project: End of project report. Retrieved from: https://www.nzagrc.org.nz/user/file/1592/Maori%20GHG%20Final%20Report.pdf

Ministry for the Environment. (2019) Arotakenga Huringa Āhuarangi: A Framework for the National Climate Change Risk Assessment for Aotearoa New Zealand. Retrieved from: https://www.mfe.govt.nz/publications/climate-change/arotakenga-huringa-%C4%81huarangi-frameworknational-climate-change-risk

Māori Land Court. (2017). Māori Land Court Website. Retrieved from: https://www.maorilandcourt.govt.nz/

Ministry of Business, Innovation and Employment & KPMG. (2017). Māori economy investor guide. At page 43. Retrieved from: https://www.mbie.govt.nz/info-services/infrastructure-growth/maori-economic- development/documents-image-library/maori-economy-investor-guide.pdf

Reid, J., Barr, T. & Lambert, S. (2013). Indigenous sustainability indicators for Māori farming and fishing enterprises: A theoretical framework. At page 4. Retrieved from: http://www.nzdashboard.org.nz/uploads/2/3/7/3/23730248/13_06_indigenous_sustainability_indicators_for_maori_farming_and_fishing_enterprises_reid_final.pdf

Te Puni Kōkiri. (2019). Te Matapaeroa.

Te Ture Whenua Māori Act 1993

Verified Market Research (2023) https://www.verifiedmarketresearch.com/product/vermicompost-market/

Conclusions and recommendations

Valerie Bianchi
Waikato Regional Council

February 2024

Complimentary conclusions and recommendations looking across all Circularising Organics Project research areas.

Conclusions and recommendations

Organic materials and their processing options need to be viewed as part of a broader set of systems.

Organics should be viewed through the lens of how they can contribute to solving other priority issues. Putting organics to their highest use will not be a priority if the issue of organic waste is viewed independently of issues such as hunger/food sovereignty and climate change. For example, when viewed independently of other priorities, organics material systems are eclipsed by other issues for iwi/Māori organisations. Therefore, ***organics material recovery systems should be developed with the view of how they can contribute positively to wider social and environmental issues; and be connected to existing central government, local government and iwi strategies.***

Contamination is an example of a wider issue that should be considered in organics material system development. End product contamination at levels exceeding a safe threshold threatens our ability to secure a regenerative circular economy, affects human health and undermines marketability. However, while contamination is a critical issue in terms of organics material recovery systems functionality, it is also a subset of wider pollution issues that must be eliminated from our environment. ***Broader policy and legislation that eliminates the products that contribute to physical and chemical organic material contamination, including regulation, bans, and phase outs, should be developed and supported alongside developing organics material recovery systems.***

A network approach will add resilience to the whole organics material system.

Networks and collaboration are key elements of a circular economy as this systemic transformation cannot be achieved through isolated actions. Applied to an organic material management system, a network approach will add resilience through adding to the overall system's processing capacity. This avoids an overreliance on only one or two large facilities, which can create vulnerabilities.

When considering processing options for organic material, it is not a question of 'either this type or that one'. A wide variety of processing options functioning together as part of a network will add resilience and variability to the broader organics material recovery system. This includes different processing types as well as a range of facilities with different processing capacities that should be chosen based on environmental, social, cultural and economic considerations. ***Policy settings should be explored to support a network approach where local, small to medium scale solutions are supported to function alongside facilities with larger processing capacity. Local government should also be supported by research that demonstrates how a network approach fits into procurement and how to use procurement in the organics space to enable local economic viability.***

Building local capability in organic material processing, including at the iwi and marae levels, can contribute to community resilience, economic growth and environmental sustainability. Community scale organics material processing as close as possible to source has the potential to connect people to place and boost local food production. ***In order for Māori communities to engage effectively in organics material management iwi/Māori organisations should be supported through the development of a business plan that connects organics material processing benefits to other***

priorities, and that demonstrates how an economically sustainable system can operate.

Communities wanting to develop local solutions have met barriers, especially with regard to accessing operational funding. ***Community groups should be supported through the development of a business plan that shows how an economically sustainable system may operate. Business plans for iwi/Māori and community should be used to identify training opportunities increase local expertise and career pathways.***

Developing national and/or regional networks of organisations that can feed back at their local level will add resilience to a broader organics material recovery system. ***There is opportunity to develop a network that provides education and expertise to support community and marae composting.***

Economic value from organic material management is reliant on high-quality product(s).

Diverting organics from landfill creates the opportunity to produce a value-added product, which would convert the current cost of landfilling organic material into a revenue stream instead. For example, there is demand for compost type end products, especially in the horticultural industry. However, the economic value of organic material relies on quality.

Contamination is a major risk to the actual and perceived value of organic materials. Expecting processors to manage contamination is problematic. In addition to regulation on products that are becoming contamination, continuous relationships and communication between feedstock producers and processors are essential to reduce contamination. Alongside policy and regulation, ***education and ongoing engagement need to be included in an organics system plan, and relationships need to be brokered to ensure contaminants are not entering the system in the first instance. Planning for collections and processing of organic material should include time and budget allocated to support continued education on system use to ensure stakeholders are engaged as part of a system***.

Each type of feedstock has different contamination issues [37]and should adopt an aligning response to contamination mitigation. To ensure high quality product, a quality system should include contamination plans that include mitigation at each stage that is managed by an organisation. For example, a territorial authority would have a contamination plan considering how food scraps are presented at kerbside, collected, processed and presented to market. The horticultural industry may consider how contamination is entering the system from seed to harvesting, then presentation of organic material for processing. ***A trial should be undertaken to test the development of contamination plans, including tracking progress through contamination auditing/data collection. A template contamination plan could then be developed that could be used throughout the Waikato region.***

[37] For example, kerbside food scraps may contain packaging. Kiwifruit chaff may contain horticultural ties or clips. Landscaping material may have been sprayed with herbicides.

Waikato
REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

He taiao mauriora — **Healthy environment**

He hapori hihiri — **Vibrant communities**

He ōhanga pakari — **Strong economy**

ISBN 978-1-99-117171-9
July 2024 #7533

Private Bag 3038, Waikato Mail Centre,
Hamilton 3240, New Zealand
0800 800 401 waikatoregion.govt.nz