Glass Packaging Forum

Product stewardship scheme design for glass

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Contents

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We were guided in our thinking by a critical friend, James Griffin, from the Sustainable Business Network.

Our colleagues in Grant Thornton Australia and Grant Thornton Sweden provided valuable insight into scheme operations in their countries.

We have also consulted widely with many stakeholders in NZ and other countries, including waste management experts, members of the large beverage producing companies, members of glass using companies, Councils, social and community organisations, waste minimisation peak bodies and the Ministry for the Environment. We would like to thank all our interviewees for their time, willingness to participate and the candour of their views which has helped and informed our review. See Appendix 1 for the full list.

Our findings, conclusions and statements are Grant Thornton NZ's own.

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Executive Summary

Glass is a unique material with properties that make it useful for a more circular economy. We have designed a Product Stewardship scheme focused on circular principles as an option to the proposed container return scheme (CRS).

We have designed a system to make the most of existing infrastructure and the convenient network of collection systems already in place, enhancing it in places where there are gaps, particularly hospitality. The design seeks to achieve the most efficient use of energy in manufacture, remanufacture and logistics and get closer to a mass balance of glass across New Zealand.

The proposed CRS would require a new infrastructure of Reverse Vending Machines and a new collection fleet of a similar size to the existing kerbside collection fleet. Beverage glass would exit kerbside collection but leave the issue of non beverage glass to be collected by Councils. The stewardship scheme would keep in place existing enterprises, many of them community based social hubs.

The stewardship scheme was designed from circular economy principles and seeks to keep materials in their highest use value for longer. The stewardship scheme design would reduce single-use containers, encourage refillables, increase the collection rate, increase the use of cullet in remanufacture, reduce contamination and increase quality, and lastly prioritise glass into its highest use when downcycling at end of life.

Our modelling shows the scheme could achieve high rates of bottle-to-bottle use and lower overall emissions than the CRS, at a cost profile similar to or slightly better than the CRS.

Background

In the early years of this century New Zealand was considered at the forefront of waste minimisation with groundbreaking legislation and a motivated government. Fast forward a couple of decades and New Zealand has in many cases only barely stood still while other countries who adopted our ideas have moved ahead.

Some areas of New Zealand, metro, semi-urban and rural have made progress, and many have ambitious plans. That said, the level of waste to landfill has continued to rise, marking New Zealand as an outlier in the global community of its peers.

Fundamentally, the New Zealand waste system is a commercial construct with many private and public sector entities operating in the system. Key elements in the system are dependent on economically effective collection, sorting and beneficiation, while requiring commercially viable end markets for reused, recycled and reprocessed materials.

The issues of geography are important. We have a long skinny country with extended distances to transport, and only some of the infrastructure required for making the required product journeys more circular. This is further complicated by disparate methods of collection in the different regions.

Recent years have seen more hope on the horizon. Consumer awareness has increased calls for real action leading to more focus being applied by industry, government, and environmental groups. A more complete Waste Minimisation Fund (WMF) investment framework has been developed by the Ministry for the Environment (MfE)[1], to result in more effective investment of the funds from the increase in waste levy, allocating more money for WMF projects and Jobs for Nature[2].

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[1] which Grant Thornton advised on

[2] both of which Grant Thornton provide due diligence to the Ministry on.

In 2020, the government announced six priority products for regulated product stewardship schemes: plastic packaging, tyres, e-waste, agrichemicals and containers, refrigerants and farm plastics.

Regulation is "used to increase circular resource use and place responsibilities for managing end of life products on producers, importers, and retailers rather than on communities, councils, neighbourhoods, and nature"[2].

The Glass Packaging Forum (GPF) is seeking for container glass to be declared a priority product so that a regulated scheme can be implemented, which will lead to a more circular system.

A few days after the GPF engaging Grant Thornton, the Ministry published their ideas on a container return scheme (CRS) as part of their ongoing Transforming Recycling programme, and invited consulation in the second quarter of 2022.

Current situation and limitations of the voluntary scheme

Glass is a unique material, that can be used almost indefinitely, either at low energy by washing and refilling, or at higher energy use by including in remanufacture where it is melted and reformed into a new container, using less virgin material and lower energy than required when manufacturing from raw elements.

NZ has an existing glass collection system and a national network. Some sectors of this are currently not well catered for, such as hospitality and some rural areas. Also, the two largest metros have put in place comingled collection, which reduces the value of all the materials when they are combined and then require beneficiation before further use.

There is an existing voluntary product stewardship scheme in place, administered by the GPF. It has reached the limits of what can be achieved by a voluntary scheme.

New Zealand has some infrastructure for collection and re-use, but there are a series of known constraints – such as a single glass container manufacturing facility – and some significant commercial concentrations of key assets.

Glass inclusion in a deposit return scheme

Collection rates are already quite high in New Zealand. There are issues with littering, and more generally New Zealand is a poor performer amongst OECD comparators in terms of waste generated, recycling rates and waste minimisation performance.

The proposed CRS has a focus on litter reduction. However, it is not clear that it will achieve the additional desired results of a more circular economy and emissions reduction. The benefits claimed for litter reduction seem high to us[3]. Admittedly, robust data is hard to find.

The CRS as proposed in the Transforming Recycling document doesn't adequately address hospitality consumption, one of the largest currently uncaptured pools of glass.

The CRS is likely to reduce the quality of the collected glass as the proposed model delivers mixed-colour glass. Many regions in the country already collect in a best-practice fashion - colour-separation at source. Our analysis and modelling show that the CRS will result in lower bottle-to-bottle recycle rates as less glass cullet will be able to be used in remanufacture.

> *Despite aiming to collect more glass, the proposed CRS will reduce the quality of glass and could end up recycling less glass back into bottles, the key circularity measure.*

We have also modelled the CRS and it shows a higher emissions profile than might be desired.

[3] Grant Thornton separately undertook an analysis for the Packaging Forum of the litter benefit claimed in the CRS cost benefit analysis.

Regulated product stewardship for glass

A well-regulated and high functioning product stewardship scheme for glass would encourage greater industry collaboration and innovative ways for the use of glass. Such schemes are in operation in other countries, such as Norway and Sweden.

Product stewardship schemes focus higher up the waste hierarchy compared to the end-of-life recycling focus for the proposed CRS. This is outlined further in the Scheme design section

Before a regulated scheme can be introduced glass needs to be declared a priority product. The Ministry will then consult with industry and those affected. If approved, a scheme can be submitted to MfE for accreditation.

The waste hierarchy for glass

Central objectives of the transformation of waste in New Zealand (MfE) and the recently released Emissions Reduction Plan are to help New Zealand transition to a more circular economy. This is an economy where products and materials are reused at their highest value.

To meet this aspiration, Aotearoa New Zealand requires a scheme based on circular principles. Organisations would consider material use in their products to design out waste and pollution from the beginning of use (rather than end of life as proposed by the CRS). The scheme should utilise the waste hierarchy to maximise the circularity outcomes for glass, achieving lower waste and associated carbon emissions and supporting more reusable and refillable pathways.

Scheme design

To achieve the ambition, we have embedded circular thinking at the core of the design. We considered the known infrastructure constraints when designing the scheme following these principles:

- Reduce single-use containers by encouraging low-packaging and refillable alternatives
- Increase the collection rate
- Increase the % use of cullet in remanufacture
- Reduce contamination and increase quality
- Prioritise glass into its highest use when downcycling at end of life.

Summary of scheme targets

Table I below outlines the product stewardship scheme targeted outcomes.

Table I Summary of product stewardship scheme targets

Target	Baseline	Year One	Year Three	Year Five
Reduce single use bottles to market	0%	-6.5%	-12.5%	-15%
Increase collection rate	75%	80%	85%	90%
Increase percentage of glass cullet in new local bottles	69%	72%	85%	90%
Bottle-to-bottle recycling rate	61%	75%	81%	87%
Reduce glass litter	-	Contestable fund of $350k p.a. to fund reduction and collection initiatives		

Scheme modelling

Outcomes that can be achieved through any scheme are influenced by inputs into the system, infrastructure limitations and end markets. In New Zealand this is especially relevant with our isolation from other markets and limited infrastructure. A reasonable criticism of the current state is that bottle-to-bottle recycling is not as high as it could be, based on collected volume. An approach not considering inputs and outputs into the system, or holding these aspects constant, will not deliver the full outcomes and environmental benefit possible.

The desire to test the possible outcomes from scheme choices led to our decision to model the entire system, from glass into market to end market capacity.

To assist with decisions and optimisations we created a digital twin of national glass consumption detailed at a level of resolution higher than previous studies – down to the level of household and bottle.

The digital twin allowed us to test based on actual geographic information, reported costs, accepted engineering and GHG emission factors for three collection network options:

1. National Kerbside network for glass (primary collection method for urban areas)
2. Reverse vending machines (as proposed by the CRS design)
3. Community collection bins at high frequency (nationwide)

The digital twin allowed us to assess the impact of any system change and to model and optimise for volume, cost, and emissions.

Our system-modelling approach allowed the following:

- Comparison between network options
- Impact of different scheme targets and levels at different years
- Comparison of network configurations to refine design
- Adding capacity constraints at key parts of the system
- Estimation of the benefit to society based on scheme targets and network costs
- Emissions profile between options
- Comparison of emissions between network configurations to refine design
- Managing agency costs to deliver the scheme
- The appropriate levy to cover managing agency costs.

It allowed us to optimise at a national systems level for cost and emissions generated considering the very real constraints in key infrastructure.

Network design

A network design of hubs and spokes was created to enable the desired outcomes from the scheme design:

- Maximise quality collections
- Minimise contamination
- Establish efficient return collection logistics
- Leverage existing infrastructure, such as logistics networks and existing transfer stations with bunkers
- Build capacity into the network by addressing bottlenecks and addressing seasonal consumption impacts

The network is modelled with every household, Spoke, and Hub having its geospatial location used to determine the optimal configuration of the network. Household volumes are aggregated to the nearest Hub using the straight-line distance. Some sense-checking occurred to ensure glass volumes weren't traversing the same stretch of road twice where avoidable.

A range of values for the cost of kerbside collection were collected from councils and waste management companies who currently operate a glass separate collection network. The associated emissions were also modelled alongside the cost.

The volumes aggregated at the Spoke level are then further aggregated to their nearest Hub, via a straight-line distance. From the Hub the volume aggregated is then shipped to the beneficiation plant in Auckland. The final leg has a mixture of road, rail, and coastal shipping. In conversations with industry experts, we were able to acquire a range of costs for each of the transport methods.

As there is a single glass container manufacturing facility in New Zealand, there is a constraint on the network. Therefore, an important consideration in the network design is that not all glass can make it back to the glass manufacturing plant, especially when glass capture rates are high. For all glass consumed in New Zealand there is an associated cost with getting it back to the furnace.

In our design we prioritise the glass which has the shortest distance to get back to the furnace until the glass manufacturing plant has reached its maximum capacity. All other glass is aggregated at the Hub level but not sent on the final leg. Other uses of the glass are considered at the point of the Hubs with more circular outcomes being the priority.

Managing entity

We modelled a managing entity including a bottom-up identification of capabilities required, roles and corresponding costs. To be consistent, we considered comparison points of the theoretical managing entity included in the MfE consultation on the CRS and also actual managing entities in the comparable Australian states of Queensland and Western Australia[4].

Summary of scheme outcomes

Table II below outlines outcomes delivered by the scheme targets.

Table II Summary of product stewardship scheme outputs

	Total glass to market	Glass collection	Furnace capacity	Expected Losses	Bottle to Bottle rate*
Baseline	258,748	194,061(75%)	161,460	>10%	**61%**
Year 1	241,929	193,543(80%)	168,480	6%	**75%**
Year 3	226,405	192,443(85%)	198,900	4%	**81%**
Year 5	219,935	197,942(90%)	210,600	<3%	**87%**

[4] Grant Thornton Australia is the auditor of these Schemes.

Cost Benefit Analysis

We modelled real benefits to the scheme and Councils, and excluded theoretical welfare benefits, which are highly subjective. We have also avoided imposing additional recycling participation costs on consumers.

In our modelling we undertook a stochastic approach (discussed further in the section "Modelling Approach") to assumptions for which there is uncertainty. This enabled us to capture the full range of possible values.

Table III Cost-benefit analysis of the proposed scheme (PV, $m unless specified)

Year	Ongoing
Benefits	
Decrease in landfill costs	$65.3
Increase in revenue from end market	$61.4
Decrease in Council processing costs	$55.9
Decrease in Council management costs	$51.8
Total benefits	**$234.3**
Costs	
Collection and transport costs	($79.8)
Managing agency operating costs	($48.6)
Purchase of kerbside collection bins	($10.4)
One-off increase in bunker capacity	($1.8)
Additional infrastructure investment	($0.3)
Ongoing bunker improvement	($7.3)
Litter reduction fund	($5.1)
Total costs	**($153.3)**
Net benefits	**$81.0**
Benefit Cost Ratio	**1.53**

We have modelled the expected range of levy required to meet the entity's net costs by year 5. The 80% confidence interval of this range is 18.4c – 22.1c per kilo, with an expected value of 20.3c per kilo.

Product stewardship scheme levy modelled range to be cost neutral

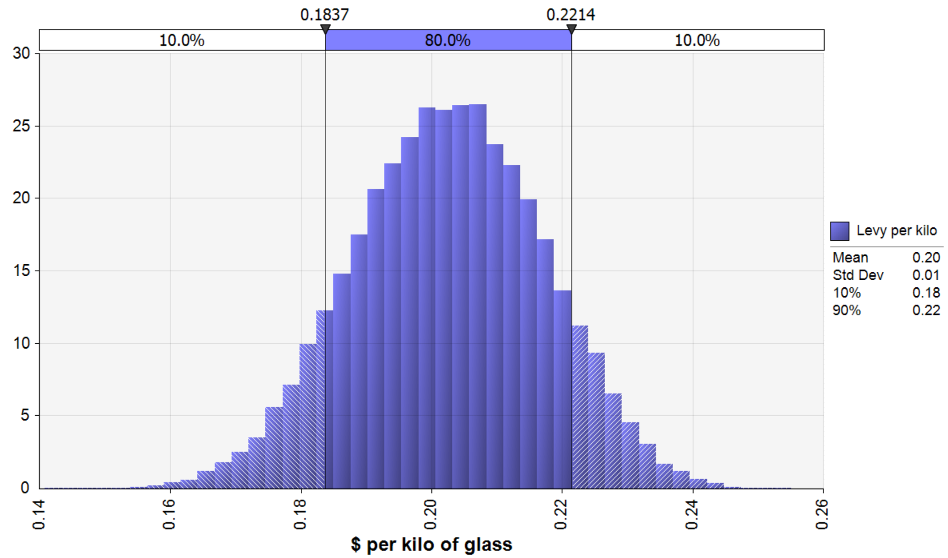


Figure 1 Modelled required levy for Product stewardship scheme

The following worked example for a 12 pack of beer in Table IV shows the expected price impact upon purchase for consumers is up to five times higher for a 20c CRS than for a Product Stewardship scheme.

The overall financial impact on a typical 12 pack consumer, factoring in an expected return rate, would be 50% lower with a product stewardship scheme than under the 20c CRS scheme.

The worked example for a typical wine bottle is less financially compelling as the single bottle is heavier, however a cost by weight rather than container is fairer and provides the market the right incentives (e.g. not incentivising a move from small volume multipacks to single larger bottles).

Table IV Price impact of 12 pack of beer and a Single wine bottle

12-pack of beer**	Fees paid	GST	**Total cost**	Avg. deposit refund*	**Net cost**
CRS (20c)	276 – 300c	41.4 – 45.0c	317 – 345c	202c	116 – 143
CRS (10c)	168 – 180c	25.2 -27.0c	193 – 207c	96c	96 – 110c
Stewardship scheme	49.0 – 58.9c	7.3 – 8.8c	56.3c – 67.7c	-	56.3 – 67.7c
Wine bottle**	Fees paid	GST	**Total cost**	Avg. deposit refund*	**Net cost**
CRS (20c)	23 – 25c	3.5 -3.8c	26.4 – 28.8c	16.8c	9.7 – 12.0c
CRS (10c)	14 – 15c	2.1 – 2.3c	16.1 – 17.3c	8.1c	8.0 – 9.2c
Stewardship scheme	8.8 – 10.5c	1.3 – 1.5c	10.1 – 12.1c	-	10.1 – 12.1c

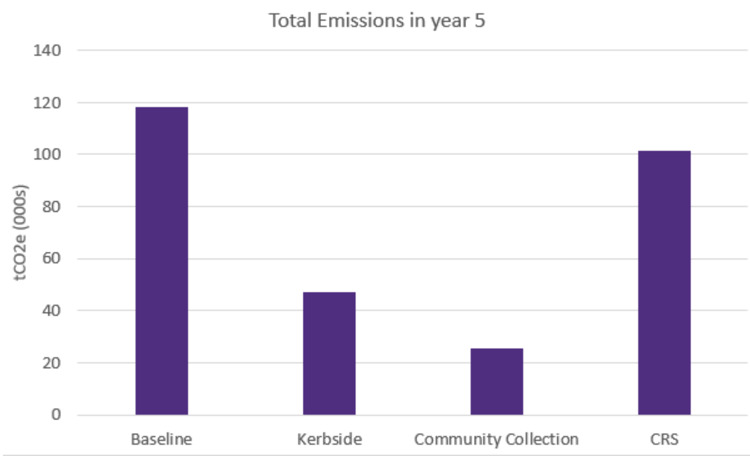
*Based on the upper end of CRS modelling of 84% return rate for 20c and 81% for 10c

**Based on an average wine glass bottle with weight of 0.476 kg, GS1/IRI weight. Based on an average beer bottle of 0.222 kg, GPF data based on recent market insight.

Greenhouse gas emissions

- The largest emissions component of the glass system is the glass manufacturing plant and so continued improvement in this area is essential to improve environmental results.
- Emissions in a regulated product stewardship scheme will be reduced by design leading to the achievement of scheme targets.
- The proposed CRS will only result in marginal improvement in total system emissions because its design does not reduce the emissions in the most significant parts of the system – the furnaces and raw materials. A kerbside collection model will be able to deliver significantly lower system emissions than the CRS.
- The furnace and raw material emissions are directly related to the quantity of high-quality cullet. The recommended method of collection - colour separation at source - is designed to provide higher quality cullet. A CRS collects less cullet compared to the product stewardship method, but more importantly, its collections are of a lower quality due to its mixed-colour collection method. Mixed colour collection limits the recycled glass that can be used in remanufacture and might actually reduce the amount of glass recycled back into bottles.
- The Community collection method would deliver the lowest system emissions, however there are trade-offs of convenience resulting in lower achievable collection rates than a kerbside model.
- Kerbside collection has the greatest long-term potential to be the least damaging to the environment, due to high levels of cullet in glass manufacturing and future opportunities for reduction in emissions in the national collection fleet.

Figure 2 Total emissions of alternative schemes in year 5



The goal: Maximise circular outcomes for glass, thereby achieving lower carbon emissions

Three Possible Solutions:

1 Current glass recycling method

Currently Councils operate recycling collections, including glass. A voluntary producer responsibility scheme works to influence and improve glass collection and recycling outcomes. NZ has a good glass collection rate, but recycling outcomes have flatlined. Significant improvements are unlikely without a change in approach.

Cost: Maximum of 0.0039c per kg of glass for each transaction by voluntary members (insufficient to cover the cost of recycling activities)

2 Proposed Container Return Scheme (CRS)

MfE have recently undertaken public feedback on a CRS, proposing to include glass containers as a CRS material. The proposed CRS will place value on an item to encourage consumers to stop both littering and stockpiling beverage containers by recouping a monetary refund if they return the beverage container to a drop off point.

Cost: 3 – 5c per bottle levy + 20c per bottle refundable deposit

Preferred

3 Mandatory Product Stewardship Scheme

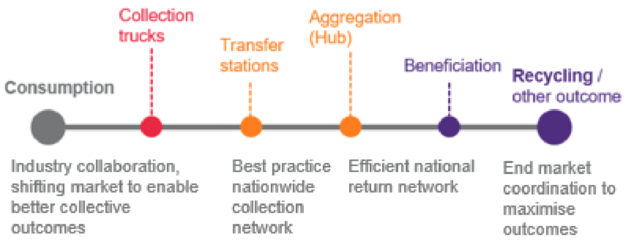
A product stewardship approach encourages careful use of resources through their life. Reducing waste by design and prioritizing circularity of resource use, schemes reduce waste, litter and other environmental harms by placing responsibility for delivering environmentally friendly outcomes on the producers.

Cost: 18.4 – 22.1c per kilo of glass

Mandatory Product Stewardship Scheme design

Based on physical and environmental fundamentals and enhancing existing infrastructure, advanced analytics was used to design a product stewardship glass system for NZ

Designed using end-to-end system design



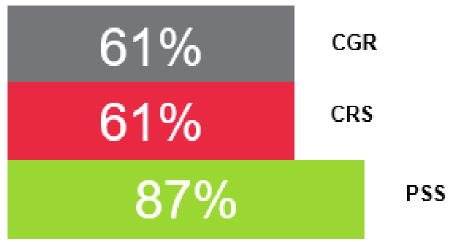
Design guided by the following principles:

- Encourage solutions higher up the waste hierarchy
- Leverage existing infrastructure
- Increase the collection rate
- Increase use of recycled glass in remanufacture
- Reduce contamination and increase collected glass quality
- Prioritise glass into its highest use at end of life

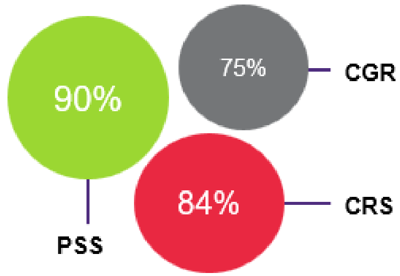
The Outcomes: A strong mandatory product stewardship scheme would outperform the CRS in key outcomes

Key:
- **CGR** – Current glass recycling
- **CRS** – Container return scheme
- **PSS** – Product stewardship approach

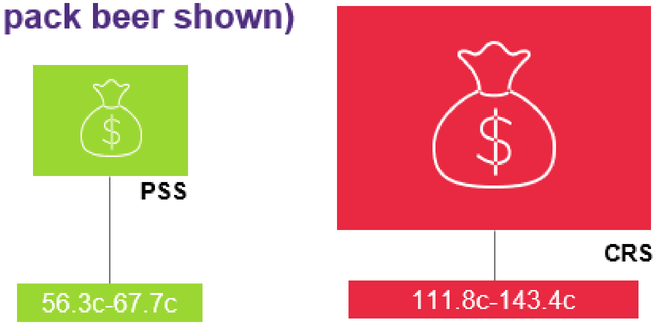
1 Higher bottle to bottle recycling rate



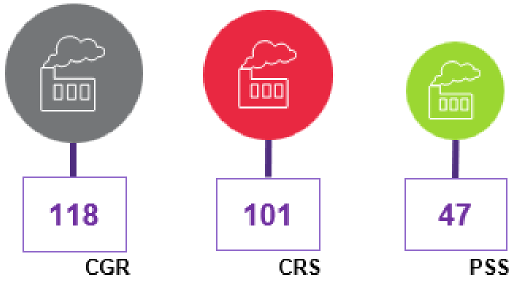
2 Higher collection rate



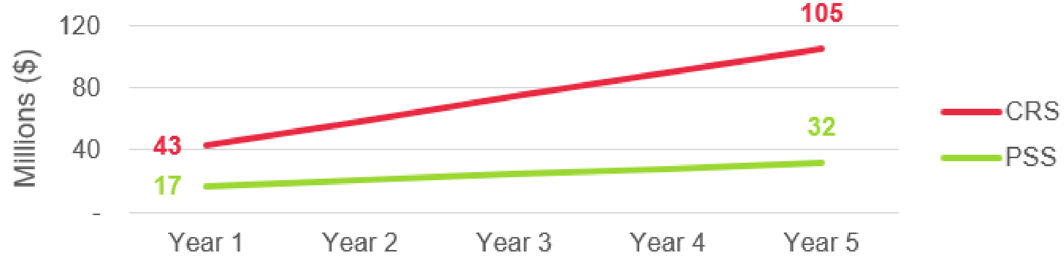
3 Lower price impact (12 pack beer shown)



4 Lower emissions (Year 5 of scheme in KtCO2e)



5 Lower spend on new infrastructure (cumulative 5 year)



Conclusion

In our conversations with the various sector players there were many common themes. One thing that struck us was the general alignment across the actors that an improved outcome was strongly desired and possible. To be sure, there were varying views as to how, but any assessment of the publications on the topic over the last 10 years or so would quickly inform a reader of that.

Our work was informed by the many experienced people we spoke to. We trust we have given their ideas and observations fair consideration and duly captured that knowledge in our work to design a stewardship scheme.

We have endeavoured to use that qualitative information, along with a unique approach on the quantitative information using a digital twin to accurately assess and compare the key metrics between three different types of schemes, one of which is a CRS.

We hope this report informs the discussion and provides useful information to the sector to make the right decision for Aotearoa New Zealand.

Terms of Reference

Background

The GPF sought a suitably qualified supplier to undertake work on the development of an industry model that has the potential to improve the Glass Capture Rate (GCR) for all food and beverage glass containers and that will allow Industry to meet the full cost of the model.

Scope of Work

The core scope of the engagement is to undertake a study and produce a findings report:

- The report will make recommendations to extract the maximum value from glass packaging through the recovery of materials, while contributing to the development of a circular economy.
- The report will consider existing services and infrastructure such as kerbside collection infrastructure and collection sites for the drop off of glass packaging by consumers, as well as how to maximise transport efficiencies.
- The report will provide the GPF with an understanding of the costs associated with glass collection and recycling and will provide indicative costs for consideration by industry by individual glass container and tonne.
- The report will be written to inform the Ministry for the Environment (MfE) and the Minister for the Environment of the outcomes of the study

Glass for the purpose of this project is defined as all food and beverage related glass packaging across the colours of: Flint, Amber, and Green Glass. Substances such as Pyrex, window glass, borosilicate glass (typically used in beauty and pharmaceutical products) and automotive glass are not included.

Out of Scope

This engagement does not include:

- Implementation of any recommendations
- As well as any activities that are not specifically identified in the Scope section above are deemed out of scope.

Deliverables

The outcome will be a report that details the indicative cost to industry, potential improvements to the glass supply chain (including the GPF Scheme) which can be widely consulted upon.

Subsequent to our being commissioned, the Ministry for the Environment announced consultation on:

> “a container return scheme (CRS) for Aotearoa New Zealand as part of the Transforming Recycling consultation.
>
> A container return scheme is a recycling system that incentivises people to return their empty beverage containers for recycling in exchange for a small refundable deposit (20 cents proposed).”
>
> The consultation closed at 11:59 pm 22 May.

Some of the analysis and insight from this work was provided to the GPF on an interim basis for their submission to the consultation.

Background

Introduction

The Glass Packaging Forum (GPF), a collective of industry stakeholders has been collaborating to achieve better recycling rates of glass in New Zealand since 2006. It operates an industry-funded voluntary product stewardship scheme that has been accredited by the Ministry for the Environment (MfE) since 2010 and was re-accredited for a further seven years in 2018.

The GPF believe they have reached an inflection point in the voluntary scheme where it is difficult to increase the collection and recycling rates without regulation or major improvements to infrastructure, collection, and collaboration across the whole industry.

While it might appear on the surface to be a complicated and difficult problem, the GPF believes that this presents a major opportunity to share and discuss the alternative ways that the glass network could be transformed to create significant benefits to New Zealand.

This report explores how a scheme and network design in a regulated product stewardship scheme would achieve more circular outcomes for glass.

Glass is a uniquely circular resource

Glass is one of society's ubiquitous and high utility materials. Like aluminium and steel, it has an abundance of uses and can be reused infinitely. It can be argued that glass has a greater capability for circularity when compared to the two metals, because glass containers can be washed, refilled and reused as well. This means that glass has significant potential for being a circular resource – if stewarded with care and attention to its unique characteristics. Glass is a proven circular material. Many alternative materials fall well short of circularity, or certainly circularity within New Zealand.

As New Zealand transitions towards a more circular economy, the case for maximising the circularity of glass has never been stronger. Circularity for glass means that any scheme or collection should collect glass in such a way as to maximise circular outcomes, utilising the unique characteristics of glass to its greatest potential. This approach would require industry and regulatory alignment – and is signficiantly broader than a 'recycling scheme'.

Current Collection Network

Glass recycling collections are currently operated in almost every district in Aotearoa by the local Councils. This decentralised approach to glass collection has resulted in disparate approaches to collection requirements, processing, logistics and end markets.

Current network overview

The current network is focused on household collections (kerbside), providing a highly convenient service to most urban areas. Kerbside collections are typically supplemented by transfer stations and drop off points for large commercial collections or for areas outside of the kerbside collection network. Rural collection methods and convenience levels vary by Council based on topography and population. Some rural areas are poorly serviced and represent an opportunity to improve the network and collection rates.

Businesses, events and hospitality venues are poorly serviced by the current kerbside collection network. Businesses are required to arrange commercial rubbish collections and must specify that glass is to be recycled (often at additional cost). Public spaces and events venues are also poorly serviced resulting in poor recycling outcomes. While recycling bins in public spaces are becoming more frequent, these are mixed collections of a number of materials. Separate bins for glass in public spaces are rare.

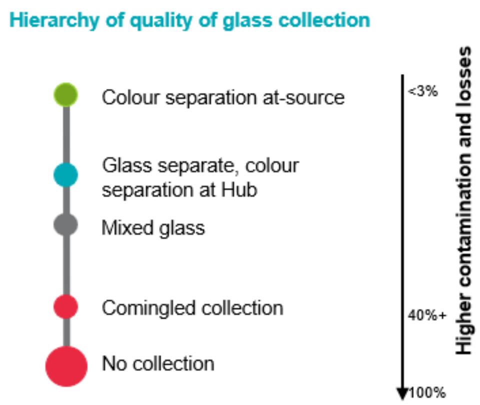


Figure 3 Hierarchy of quality of glass collection

Collection types currently used

Glass recycling collections fall into one of three general categories:

1.	Colour separated	Glass separated, colour-separated at source
2.	Mixed glass	Glass separated, mixed colour glass
3.	Comingled	Comingled recycling collection

Colour-separation at source produces very low contamination (below 3%[5]), resulting in much lower processing costs and material loss during processing leading to higher recycling outcomes**. Mixed glass** can be low in contamination, however, requires additional processing and the mixed colours limit the amount of recycled content in bottles produced from it. **Comingled materials** require substantial sorting and additional processing resulting in higher losses during processing as materials contaminate one another. After processing the resulting cullet is still of low quality, substantially limiting the amount of recycled content in bottles produced from it.

There has been an ongoing shift up the hierarchy in the quality of glass collection, supported by GPF's advocacy and end market demand for quality cullet. Currently 79% of Councils undertake colour separation at source, covering 49% of the population (Figure 4).

If all kerbside collections were using best practice, separation at source, there is a significant opportunity to increase the recycling (bottle to bottle) rates of glass already being collected.

The cost to deliver is a major barrier to changing the way that Councils make decisions on collection method and kerbside collections to improve the reach and recycling outcomes. Councils are challenged by the geographic spread of consumption, limited recycling infrastructure and limited end markets. In some locations these issues are exacerbated by seasonal population influxes that result in higher quantities requiring collection.

Collaboration between Councils in glass collection networks have become more common among those Councils in proximate locations. Collaboration has been successful in helping achieve economies of scale and highlights the opportunity for efficiencies in a national approach to glass collection.

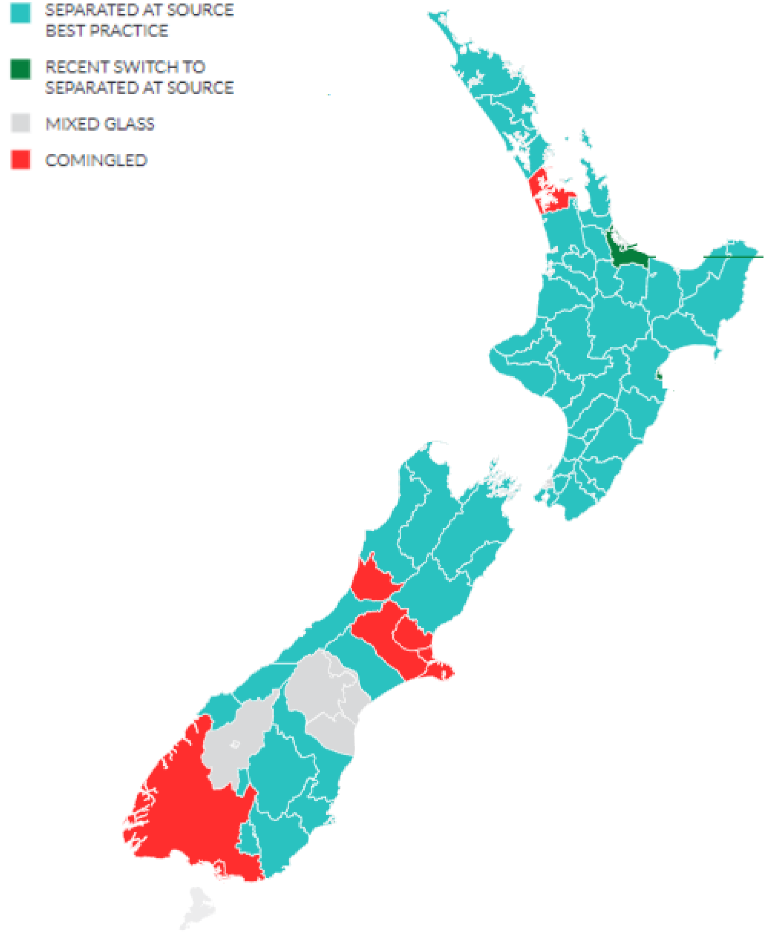


Figure 4 Current glass collection methods in New Zealand[6]

[5] Private conversation, Visy

[6] Glass Packaging Forum – 2022 Accreditation report

Current Voluntary Scheme

The current structure the GPF operates is a voluntary product stewardship scheme. The scheme is funded by a voluntary levy paid by its 62 members, representing over 100 member brands, on the glass they release to the New Zealand market.

Under the voluntary scheme, the key performance indicators are:

Table V Voluntary scheme targets

KPI	2024 Target
Contribute to and collate data to identify glass recycled as % of consumption by weight	74% - 2017 78% - 2020 82% - 2024
The cost of glass recycled from projects funded from scheme for Infrastructure	2015/2016 based - 43,684t 2017/2024 target - 79,000t
Record tonnes of glass into high value including container manufacturing and low value	No target (Just a record)
Percentage of the glass market represented by GPF membership	90% industry
Communicating with local government ensuring that relevant personnel are familiar with the GPF opportunities	Direct contact with the operational staff of 40 Councils to ensure awareness of glass opportunities
Engagement with Recyclers of New Zealand and Community Networks, Waste Management Operators, Roading and Construction services providers.	Direct contact with the operational staff of 10 relevant industry and CRN members to ensure awareness of glass opportunities
Glass recycled due to projects or funding from the scheme for Events/Consumer Awareness	Annual Budget
Budget vs Actual for planned grants programme Infrastructure/Events/Education & Research	Annual Budget

The scheme facilitates stakeholder relationships to improve glass outcomes and offers expertise and information to develop future thinking. The GPF improves environmental outcomes for container glass through grant funding for projects via a contestable fund and the projects can be infrastructure, plant, public place recycling or research which improves glass recovery. Grant funding is considered in three rounds per year to enable applications across the sector to be compared to ensure the decisions on which projects are funded meet the required criteria of improving glass recovery outcomes and make the best use of available funds.

Advances made under the current operating model

In 2018, MfE re-accredited the voluntary product stewardship scheme for glass, and with that comes a responsibility to publish an annual accreditation report. These reports detail the latest information on recycling and collection data for glass. This includes financial reporting data, funding and activities completed during the year and mass balance reporting.

We have summarised the key areas where the GPF has made and is continuing to make progress towards increased collection and quality of glass to deliver more circular outcomes (Table VI).

Table VI Voluntary scheme outcomes

Year	Infrastructure	Quality	Collection	Other
2020 / 2021	Grant Funding of $237,651 was allocated to 15 infrastructure projects for glass recovery.	Collectively this had a positive impact of circa 11,500 tonne of glass per annum 61% bottle-to bottle recycling rate	Christchurch City Council is considering a change to separate collections as part of its solid waste review 75% container glass recovery rate	Improving data quality by gaining independent assurance over the mass balance data methodology
2019 / 2020	Grant Funding of $215,472 was allocated to 15 infrastructure projects for glass recovery.	Collectively this had a positive impact of circa 7,136 tonne of glass per annum 62% bottle to bottle recycling rate	75% container glass recovery rate	Improving data quality by gaining independent assurance over the mass balance data methodology
2018 / 2019 **First Year of re-accreditation**	Grant Funding of over $457,000 was allocated to 18 infrastructure projects	71% bottle to bottle recycling rate	73% container glass recovery rate	

Practical limitations of the voluntary model

The voluntary scheme model has reached a practical limit, as shown by a flattening of recovery and recycle rates. To go beyond current scheme performance, greater alignment and collaboration of industry players is required, along with changes to the commercial model. Under a voluntary scheme the GPF faces several headwinds in advancing more circular use of glass in New Zealand including free-riders, data and reporting quality and accuracy, disparate collection methods, market demand and limited recycling infrastructure.

Membership / free rider challenge

Due to the voluntary nature of the current scheme, maintaining membership has always been vital. The GPF notes that membership is seen at best as a nice to have, and at worst as a competitive disadvantage due to cost.

A regulated stewardship scheme would strengthen membership and level the industry playing field. This would in turn scale up the scheme's ability to positively impact glass outcomes, both in terms of recycling outcomes, and also coordinating industry-wide initiatives that improve the circularity of glass.

Receiving data and reporting

As a voluntary stewardship scheme, there is no requirement for those in the supply chain to provide data. Reporting gaps can cause additional effort to close or limit accuracy of year-on-year comparisons. Quality, auditable data is essential for regulated schemes, supported by the resource levies that cover the cost of scheme operation. The industry will rightly want confidence in scheme expenditure, and in the fairness of the levy paid by all members. Regulatory support is required to ensure there is standardisation of points of declaration and quality of reporting across the industry.

Disparate kerbside collection methods

In the absence of a national managing agency or national recycling coordination and standards for glass, disparate approaches to collections have resulted. The GPF only has advocacy and infrastructure grants as tools to improve collections.

Colour separation at source is proven to deliver the greatest quantity and quality of glass collections and is considered best practice. Despite a positive trend towards glass-separate collection by Councils, currently the proportion of residents whose Council uses a co-mingled collection system is still higher than those with glass separate or colour separated collections – limiting the quality and quantity of recyclable glass under the current model and increasing the volume going to landfill.

Market demand for recycled glass

New Zealand's single bottle manufacturing plant has a reasonably high recycled content rate compared to international peers, and lower GHG emissions – a great result for glass circularity. However, because the furnace is the largest single GHG emitter in the scheme any improvement has a significant effect.

To date there has been a surplus of cullet available enabled by the high volume of collected glass.

The imbalance is worsened by glass imports. While some is exported, there is a net import to the system. The net result of this is more bottles in market than the manufacturer is capable of making into new bottles. It is not a closed loop.

Local recycled glass bottle manufacturing is already running at high capacity, a key limitation when looking to increase collections and recycling outcomes. This is the same conclusion found in the CRS design, where additional collected glass was expected to be crushed and stockpiled.

There are three current limitations that are impacting on any further material improvement in the levels of recycling:

1. **Sufficient high-quality glass cullet.** To achieve high levels of recycled glass in new bottles high-quality cullet is required. This means very low contamination and colour closely matched to demand for the colour of glass manufactured (flint, green and amber separated). Wider use of mixed glass collections or higher contamination levels would put the current recycled content levels at risk.
2. **Industry support for high-cullet content bottles.** The local manufacturer delivers on orders from producers. If producers demanded higher recycled content in bottles, then this could be delivered. The trade-off is the potential for slight discolouration of the bottle colour (possibly only noticeable in flint, see refillable scheme case study by ABC in Scheme Design section). If producers accepted a slight discolouration in bottle specifications, then higher recycled content bottles could be manufactured.
3. **Consistent supply of cullet.** Glass furnaces run 24/7/365. This means that a furnace requires consistent input of glass cullet throughout the week, month, and year. To get consistent use of cullet in manufacturing requires cullet to be always available – instead of just at peak times of the year.

Increasing market demand for glass cullet in New Zealand requires these limitations to be addressed.

An industry-led stewardship scheme has the potential to positively influence demand for recycled glass by participants demanding higher recycled-content containers from their manufacturing facility. Through the additional glass recycled into bottles the circularity of glass in New Zealand is significantly improved and we can become leaders in glass reuse.

Limited glass recycling infrastructure

There are several limitations to the current infrastructure in glass manufacturing and recycling in New Zealand, both in infrastructure and location to support circularity of glass:

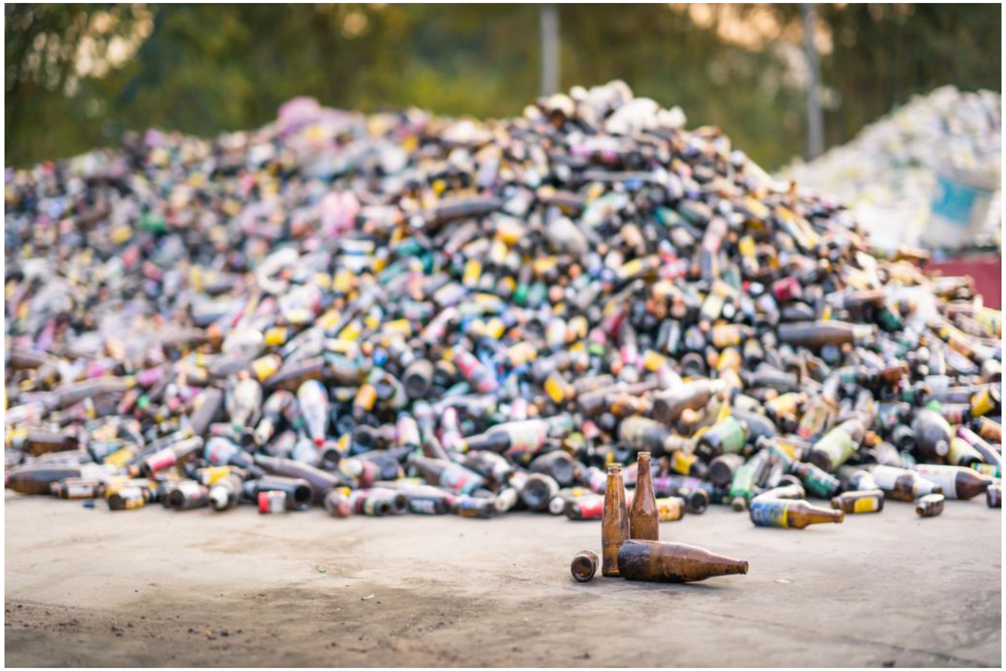
- A single glass beneficiation plant (Central Auckland)
- A single glass furnace / bottle manufacturing facility (Central Auckland)
- One wash and refill scheme with national reach, supplying two companies (plus small-scale regional refill schemes)
- Two large MRF[7]s used for glass separation from co-mingled (Auckland and Christchurch)
- A small number of commercial-sized, glass-grade crushers (Including in Auckland, Christchurch, and Central Otago)
- There is no glass furnace for flat glass in New Zealand (all flat glass is imported and cut to specification here[8])

Under a voluntary model there is limited ability to influence and invest in fit-for-purpose infrastructure which would support circularity of glass. Under the current voluntary model with collections managed by Councils, this national infrastructure is fragmented and potentially underutilised.

[7] Material Recovery Facility

[8] While this is a separate market and type of glass, a portion of flat glass can be used as cullet for container glass manufacturing and a flat glass manufacturing facility could be an end-market for collected container glass.

Increases in glass recovery rates will need to be met with additional investment in processing infrastructure to achieve improved outcomes. Without addressing the bottlenecks in processing with investment, collected glass will merely pile up.



Section Summary

- Glass is a unique material with potential for more circular use
- NZ has a good collection rate and a national network however, the two largest metros have put in place comingled collection, reducing the value of the waste streams, and requiring beneficiation before use
- The collection and bottle-to-bottle rates have flatlined
- There are known constraints to the infrastructure, and some significant commercial concentrations

Glass inclusion in a return scheme

The CRS Proposal

MfE have recently released a consultation document for public feedback with three proposals relating to transforming recycling in New Zealand:

1. Container Return Scheme
2. Improvements to household kerbside recycling
3. Separation of business food waste

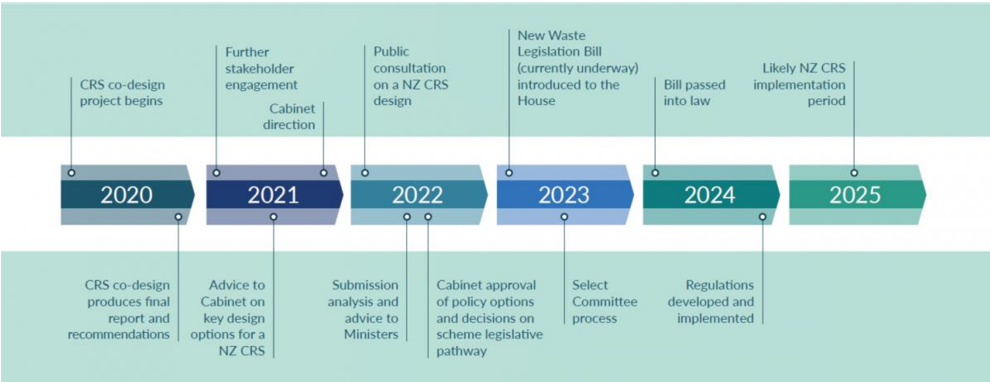
In this section we focus on summarising the key components MfE are proposing for the Container Return Scheme (CRS).

A CRS incentivises the return of empty beverage containers for recycling in exchange for a small refundable deposit. The proposed CRS will place value on an item to encourage consumers to stop both littering and stockpiling beverage containers by recouping a monetary refund if they return the beverage container to a drop off point.

The Proposed timeline

Below is the timeline that MfE have included in their CRS proposal.

Figure 5 Timeline for the proposed Container Return Scheme



2020: CRS pilot co-design project begins; CRS co-design produces final report and recommendations

2021: Further stakeholder engagement; Advice to Cabinet on key design options; Cabinet direction

2022: Public consultation on a NZ CRS design; Submission analysis and advice to Ministers; Cabinet approval of policy options and decisions on scheme legislative pathway

2023: New Waste Legislation Bill (currently underway) introduced to the House; Select Committee process

2024: Bill passed into law; Regulations developed and implemented

2025: Likely NZ CRS implementation period.

At the time of writing, the 2022 consultation period for public feedback has closed. The Ministry will now analyse and summarise the feedback received and present this to Ministers and Cabinet. The Government will still need to make a final decision on whether to implement a CRS in NZ.

Refundable Deposit Amount

The current proposal is that a 20-cent refundable deposit will be paid for all eligible beverage containers within the scheme. This means that beverage producers would add the scheme fee and deposit amount to the price of their beverage container at the point of purchase. Once the beverage container is returned to an eligible drop off zone, the consumer receives a refund of the deposit amount.

How is glass and the CRS related?

MfE are proposing that all single-use glass beverage containers would be included in the scheme. This means the 20c deposit (plus 3-5c scheme fees) would be applied to all single-use glass bottles. This is 26.5 – 28.8c after adding GST. All other glass (such as food glass packaging) would be excluded from the scheme and would continue to be recycled through kerbside collection as it is now.

Reservations about CRS and the initiation of a Regulated Product Stewardship Design

Just prior to the announcement of the CRS consultation document, the GPF appointed Grant Thornton to explore what a regulated product stewardship scheme could look like for glass that is informed by robust data, with input from industry, communities and behaviour change experts.

The CRS consultation documents, and public presentations gave us good insight to the direction MfE is heading in terms of transforming recycling and minimising waste in New Zealand.

During the consultation and subsequent publicity, litter was raised as a key focus. The benefits from litter reduction were claimed to be very high in the cost benefit analysis (CBA) issued during the consultation. In other analysis we performed[9] we determined the CBA relied on litter data. This data, while it is the best we have, is not as robust or comprehensive as would be desired. The benefit claimed was considerable, based on willingness to pay studies sourced from overseas countries some time ago. We also formed a view that using weight as a metric of disutility unfairly over-represented the impact of glass in litter.

However, we think that the focus on litter perhaps distracts some from considering the main issue. Litter is a problem, no doubt, but there are larger ones in our view.

Also emphasised in the consultation and publicity was the sheer volume of beverage containers being used in New Zealand (glass, plastic, and aluminium). This volume does represent a large amount of energy and materials, to manufacture, to move to the consumer and to collect and return.

Our concern is that if the CRS is considered to be a good way to manage litter down, it might an expensive one and it will leave behind some of the useful parts of the current system. The focus on recycling does not address the more important levels of the waste hierarchy.

Many in the industry and those who know glass well believe that through the enhancement of existing legislation (The Waste Minimisation Act 2008), better glass recovery and recycling rates can be achieved through kerbside collections and works alongside a CRS for other materials.

9 "Litter Analysis Review", Report to Packaging Forum, 2022

Most Councils operate best practice for collection

The majority of the small to medium sized Councils in New Zealand now operate glass-separate recycling, with colour-separation at source. This is industry-accepted best practice to recover the best quality of glass, minimise contamination and keep glass at its highest use and value. This highly convenient collection network results in a relatively high recovery rate of 75%. The CRS might put this collection rate at risk by reducing the convenience of glass collection.

Diminishing the value of glass

Under the current proposed infrastructure for the CRS, the whole country would move to a system with mixed glass collection. Much of the country is currently colour-separating glass at source, so the mixed method reduces the value of the glass collected and would increase the glass processing costs and losses. Additionally, it will require a large portion of glass cullet to be down-cycled - reducing the circularity of glass.

The biggest challenge for a CRS would be to ensure that the quality of glass collected is at the very least maintained, and ideally improved, so that the recycling rate can at least be maintained. Mixed glass will not be able to improve the recycled content of glass, as cullet cannot be colour-matched with new bottles. Colour-separation has been one of the major foci of the GPF, and the reason it has had such a strong focus in funding grants and advocacy relationships for glass separate kerbside collection, colour separated at source.

The proposed CRS appears to be a collection of mixed glass from a hybrid model which we believe will reduce the quality of glass and circularity solutions that glass can provide New Zealand

Hospitality is a large opportunity for increase collections

Collection solutions are required for hospitality, event venues, and public spaces, as these areas are not well serviced through the current network. Consumption of glass bottles at hospitality venues is the largest value at stake - this represents the most significant opportunity to improve the collection network and is essential if we are to reach 90% collection in five years. The CRS does not directly solve this area of glass consumption and any market-based solutions that arise afterwards would be slow to form and likely not provide a national solution.

The CRS CBA benefits claimed rely on welfare benefits of litter reduction. But we think litter is not the main point – material and energy use are.

Section Summary

A product stewardship scheme should deliver an easy to understand, single glass collection system which would boost recycling figures by capturing all types of glass containers (not just beverage) in one stream. This will increase the quality of the collected material and lift the amount of circular material use. It will be more cost-effective during implementation and reduce the burden on consumers in contrast to a CRS:

- The CRS focus is on litter reduction however, it is not clear that it will achieve the desired result.
- Collection rates for glass are already high in NZ with the current infrastructure in place in the majority of small to medium sized Councils.
- The CRS CBA benefits claimed for litter reduction seem high and are largely estimated welfare benefits based on data with limitations. But we think litter is not the main point – material and energy use are.
- The proposed CRS doesn't adequately encourage better outcomes in hospitality, one of the largest currently uncaptured pools of glass.
- The CRS mixed collection method will reduce the quality, value of the resource, and likely reduce the amount of glass able to be recycled into bottles.
- A number of container return schemes internationally exclude glass and product stewardship schemes run in parallel.

Regulated Product Stewardship for glass

What is a product stewardship scheme?

There are many definitions of product stewardship, however generally it is described as a methodology that encourages circularity of resources as well as reducing litter, waste, and other environmental harm from the resource. Internationally similar schemes are called Extended Producer Responsibility (EPR) schemes.

A Product Stewardship (PS) Scheme places that responsibility on the programme participants which could be manufacturers, producers, importers, and retailers; rather than on communities, councils, neighbourhoods, and nature (Ministry for the Environment, 2021). This means that right from the formation of the product or resource the scheme participants accept the responsibility and place emphasis on better environmental and societal outcomes at the forefront by designing out waste. A PS Scheme also helps to reduce waste and litter pollution because systems are put in place to use and re-use the products and materials in a more efficient and effective way. The PS design process encourages the transition to a more circular economy model rather than the traditional linear take-make-waste approach.

Product stewardship schemes (or EPR schemes) are increasingly common around the world, including in Canada, European Union Member States, Japan, Korea, Norway, many States in the USA, and Australia. According to OECD research, there are over 400 EPR systems (predominantly implemented post 2001). (OECD , 2016).

High performing systems are not exclusively the province of deposit-based systems. Countries such as Belgium, the Czech Republic and Spain obtain similar (high) rates without a deposit refund system as those who do. Instead, they have well developed EPR. Two countries with very high recycle rates – the Netherland and Germany, have both EPR and deposit refund systems[10].

[10] Deposit-Refund System Facts & Myths, 2019, Deloitte (Poland)

Product stewardship in New Zealand

Part 2 of the Waste Minimisation Act for New Zealand defines Product Stewardship as:

> *"The purpose of this Part is to encourage (and, in certain circumstances, require) the people and organisations involved in the life of a product to share responsibility for*
>
> *(a) ensuring there is effective reduction, reuse, recycling, or recovery of the product; and*
>
> *(b) managing any environmental harm arising from the product when it becomes waste."*

In June 2020, the Associate Minister for the Environment declared six priority products for regulated product stewardship under the Waste Minimisation Act (see Table VII below).

According to MfE and at the time of writing the status of the priority products are:

Table VII Designated priority products

Product	Latest progress
Plastic Packaging	Scheme co-design has not started for plastic packaging
Tyres	Scheme has been accredited by the Government and is due to Launch a pilot late 2022 and be fully operational in 2023
Electrical & Electronic products (e-waste including large batteries)	Scheme applications are expected late 2022
Agrichemicals and their containers	Scheme co-design has been completed
Refrigerants	Scheme co-design has been completed and an application has been submitted.
Farm Plastics	Scheme applications are expected late 2022

This declaration is part of a wider plan to reduce the amount of rubbish ending up in landfills or polluting the environment (Ministry for the Environment, 2021). It has created an opportunity for all participants to co-design schemes involving industry.

Requirements for a regulated product stewardship scheme

In order for glass to become a regulated or regulated product stewardship scheme, an application must be submitted to MfE under the Waste Minimisation Act (2008).

Glass' route to regulated product stewardship

The first step in a regulatory product stewardship scheme is the requirement for the product to be declared as a priority product.

In order for this to happen, the Minister must be satisfied that product can be effectively managed under a product stewardship scheme and:

Either:

i. the product will or may cause significant environmental harm when it becomes waste, or
ii. there are significant benefits from reduction, reuse, recycling, recovery, or treatment of the product.

The six priority products that have been declared for a regulated product stewardship scheme are products that cause significant harm to the environment if not disposed of in an appropriate way, which ideally is a way that enhances circularity and keeps them out of landfill. Glass is sometimes considered to be a non-toxic product, in that if disposed of incorrectly it is non leaching and is less materially harmful to the environment and society than other products.

Due to these benefits, the declaration of glass to be included in the priority products category, needs to ensure the proposed scheme covers the definition of providing "*significant benefit from reduction, reuse, recycling, recovery, or treatment of the product."*

Any priority product declaration will be notified in the New Zealand Gazette. If required, ministerial guidelines about the product stewardship schemes will be provided.

Before new regulations are passed, MfE will consult with those who might be affected by the regulations. This includes manufacturers and brand owners who sell their product in New Zealand and any scheme managers who have an existing accredited product stewardship scheme for the same product.

If the Minister declares a priority product, a regulatory product stewardship scheme is developed within the first year, and accreditation for the scheme can be obtained within three years.

If the Minister accepts the application required for a priority product, Industry needs to undertake an accreditation application to have their proposed scheme design approved.

Any scheme must meet further criteria[11] some of which are condensed here:

Governance:

- The scheme will be managed by a legally registered Not for Profit entity
- Annual independent audits are required, and performance reported to MfE (these reports will include financial performance and scheme effectiveness, environmental performance, and agreements with scheme service providers)
- Demonstrate how net community and environmental benefits will be the result of the scheme.
- Directors or governance boards will be appointed through an open and transparent process and represents interested of producers and consumers

Scheme operations:

- Services are procured
- Communication to all stakeholders is clear
- All people are trained appropriately for their role in the scheme
- Infrastructure permits are obtained correctly.

Targets

- The scheme will have set targets which will be reported annually to MfE
- These targets will be reviewed and adjusted no less than every three years from the date of accreditation.

11 Expected Product Stewardship Scheme Contents, MfE, NZ Gazette 29 July 2020

Section Summary

- A well-regulated and high functioning product stewardship scheme for glass would encourage greater industry collaboration and innovative ways for the use of glass. Such schemes are in operation in other countries
- Product stewardship schemes focus higher up the waste hierarchy, compared to the end-of-life recycling focus by the CRS
- Before a regulated scheme can be introduced glass needs to be declared a priority product
- The Ministry will consult with industry and those affected
- If approved, industry participants will need to apply for a proposed accredited scheme to MfE.

The waste hierarchy for glass

The circular economy and end of life of glass

A central objective of the new Waste Strategy and the recently released Emissions Reduction Plan is to help New Zealand transition to a more circular economy. This is an economy where products and materials are reused at their highest value

The Ellen MacArthur Foundation "butterfly diagram" illustrates the continuous flow of materials in a circular economy through two cycles - biological and technical (see Figure 6).

In the biological cycle, the nutrients from biodegradable materials are returned to the Earth to regenerate nature.[12]

In the technical cycle, products and materials are kept in circulation through processes such as reuse, repair, remanufacture and recycling.

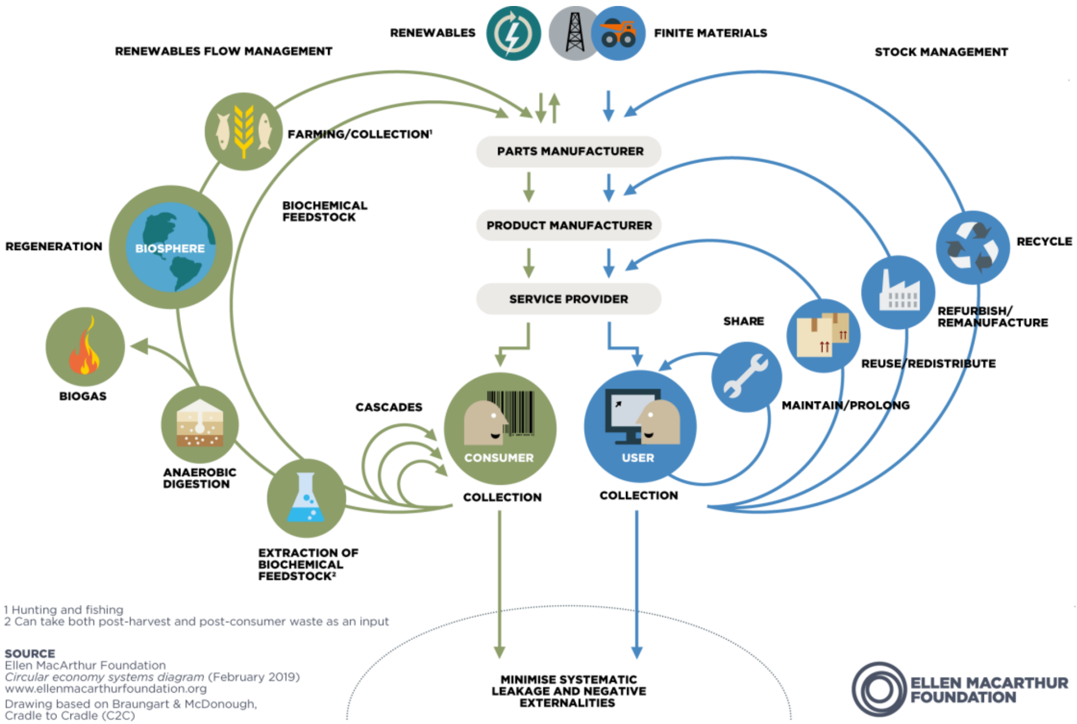
Glass has an important role to play. It is 100% non-toxic, does not leach chemicals, and is structurally solid, making it an ideal material for refillable solutions that are highly circular. Making new glass from recycled glass reduces emissions and energy use by decreasing the need for virgin materials.

The CRS circular economy objectives and targets to recycle single use beverage containers at end of use is misaligned with circular economy fundamentals because it begins at the end: recycling is the best way to 'get rid' of a product at the end of its lifecycle.

By contrast, a truly circular economy starts at the beginning - how can we avoid the waste and pollution from being created in the first place.

In the current environmental crisis, recycling is simply not enough to overcome the problem of the amount of waste that we produce[13].

Figure 6 The Circular Economy Systems Diagram ("Butterfly Diagram") Ellen MacArthur Foundation



12 Ellen MacArthur Foundation

13 Ellen MacArthur Foundation

Introduction to the waste hierarchy

The waste hierarchy (Figure 7) is a framework that aims to establish the order of preference for different waste management options. It is encouraged that a product goes through a number of levels within the hierarchy before it reaches its final destination (landfill or final disposal).

Step One: Reduce

The aim is to reduce and prevent the amount of waste being produced.

- For glass this means reducing the quantity of single-use glass to market, particularly by increasing low packaging alternatives such as keg and pour or bottle swaps.

Step Two: Re-use

The aim is to re-use the materials for the purpose for which they were designed for.

- For glass this would be reusing glass bottles by refilling, i.e. bottle refill solutions.

Step Three: Recycle

The aim of this step is to recycle the products as much as possible, so we ultimately reduce the waste to landfill.

- For glass this is availability for collection and having several ways it can be recycled to eliminate it going to landfill.

Step Four: Recover

Recover the raw energy and raw resources in the waste product

- For glass this is the ability to recover it from going to landfill and put to alternative use, such as roading aggregate.

Step Five: Dispose

Disposal at landfill. Since glass is infinitely recyclable, there should be no waste after steps One through Four. If there is, this is the absolute last option. Likely the result of contaminants or gap in the resource management scheme in place.

The waste hierarchy

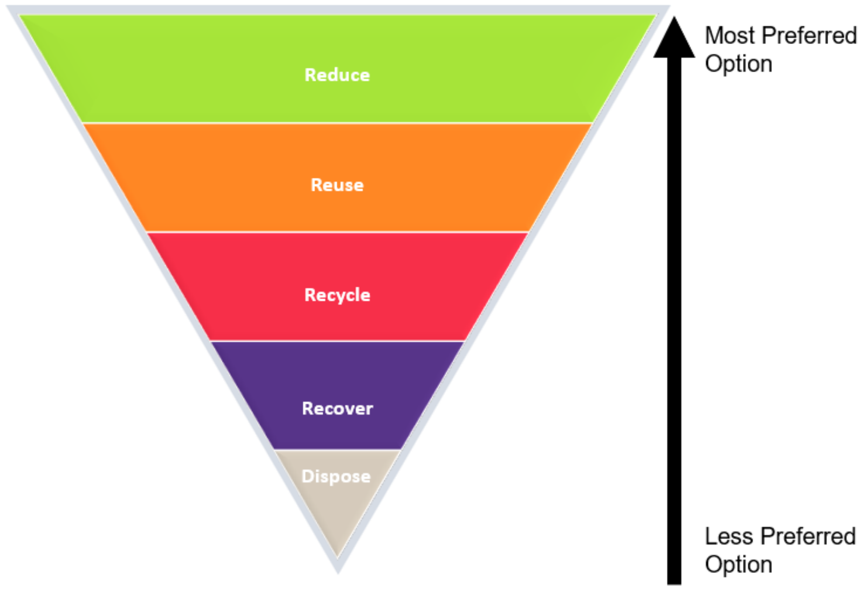


Figure 7 The Waste Hierarchy - Zero Waste Network Aotearoa

Relationship between circularity, the waste hierarchy, and emissions

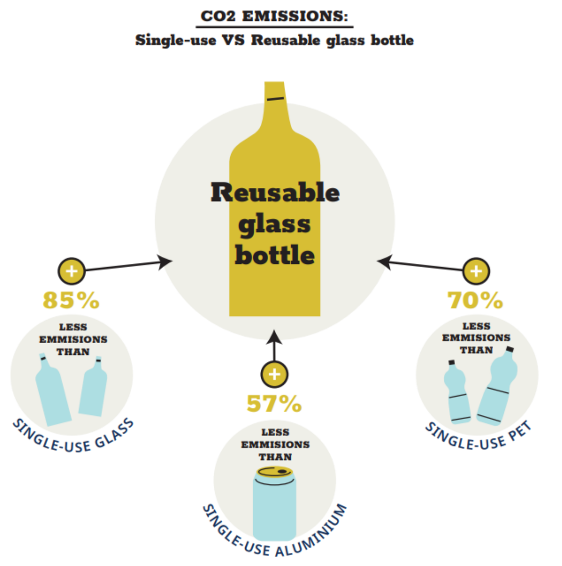
Reuse schemes that are higher up the waste hierarchy, contribute to reduction in virgin material use and GHG emissions. Globally there has been considerable investigation of life cycle analysis (LCA) for beverage containers. It is fair to say that each situation is somewhat unique. Glass is heavy, and the length of transportation is important to consider when doing an LCA. At a certain distance, studies have shown that switching from glass bottles to reusable PET makes sense for example. However, the general conclusion is clear. A meta-study examining 32 LCAs[14] shows the carbon emissions of a reusable glass bottle are 85% less than single use glass. The more times a bottle is used, the more carbon emissions reduce. Some schemes, operating for decades now, have bottle re-use rates in the order of 40 to 50 times. Glass bottles are reused up to 50 times before losing quality, while PET plastic can be up to 25 times.[15]

European countries achieve high rates of recycling of packaging. There are a variety of scheme approaches[16]. Some countries including Denmark (2nd in rate of recycling, 2016), the Netherlands and Germany use DRS schemes to contribute to raising rates. Other countries such as Belgium, Czech Republic and Spain achieve similar results without an official operating deposit-refund system. Many use a mixed model, with glass either excluded, or partly excluded from the DRS, such as Sweden.

The Container Return Scheme Interim Regulatory Impacts Statement[17] states that "manufacturing glass is very carbon intensive"[18]. An implication might be taken that glass packaging per se is energy intensive. If we take a systems view, the picture changes. Glass manufacture is more energy intensive than plastic. Aluminium manufacture is also very energy intensive. Glass is heavier than plastic and aluminium to transport. But when glass is refilled and reused three- or four-times glass is more carbon friendly than other packaging options commonly used in New Zealand (see Figure 8). Some have gone so far as to describe glass as "the hidden gem in a carbon neutral future"[19]. New Zealand waste experts have concluded similarly[20].

Internationally DRS schemes have not supported refillable schemes, in contrast, new DRS schemes implemented in Europe, such as Germany, have resulted in reductions to refillables. A return deposit scheme introduced into New Zealand will not support refillable use, and likely (because of its legislative mandate) will not be able to.

Figure 8 From Patricia Coelho, Blanca Corona, Ernst Worrell, Reusable vs Single-Use Packaging: A Review of Environmental Impacts, 2020



[14] Patricia Coelho, Blanca Corona, Ernst Worrell, *Reusable vs Single-Use Packaging: A Review of Environmental Impacts,* 2020 https://zerowasteeurope.eu/wp-content/uploads/2020/12/zwe_reloop_executive-summary_reusable-vs-single-use-packaging_-a-review-of-environmental-impact_en.pdf

[15] Tamsin Walker and Jennifer Collins, *How does Germany's bottle deposit scheme work?* DW Made for Minds, https://www.dw.com/en/how-does-germanys-bottle-deposit-scheme-work/a-50923039

[16] Deloitte, *Deposit-Refund System (DRS) Facts & Myths*, 2019

[17] Ministry for the Environment, *Interim Regulatory Impact Statement*, 2022, https://environment.govt.nz/assets/publications/Interim-regulatory-impact-statement-A-container-return-scheme-for-Aotearoa-New-Zealand.pdf

[18] *Ibid*, page 46, number 169.

[19] Nature Editorial, *Glass is the hidden gem in a carbon-neutral future,* The international journal of science, 4 November 2021 https://www.nature.com/articles/d41586-021-02992-8, and Patricia Coelho, Blanca Corona, Ernst Worrell, *Reusable vs Single-Use Packaging: A Review of Environmental Impacts,* 2020 https://zerowasteeurope.eu/wp-content/uploads/2020/12/zwe_reloop_executive-summary_reusable-vs-single-use-packaging_-a-review-of-environmental-impact_en.pdf

[20] Hannah Blumhardt, Liam Prince, *The Rubbish Trip: Helping humans walk the talk on zero waste,* 2018 http://therubbishtrip.co.nz/be-a-tirading-kiwi/sometimes-smashing-sometimes-crushing-the-story-of-glass-in-new-zealand/

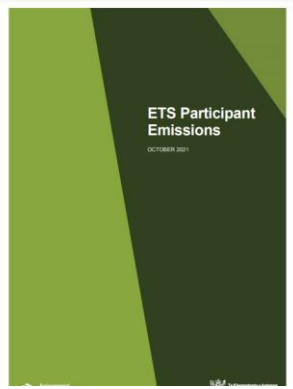
GHG Emissions for glass in New Zealand

In the 2021 reporting year[21], the total emissions for mandatory and opt-in reporters was 70,940,525 tonnes carbon equivalent (tCO_2e).

Of this, ‘Producing glass using soda ash’ reported 11,816 tCO_2e, which is 0.2% of reported emissions. This is a result of the carbon dioxide released from the chemical reaction upon combining raw materials for the manufacture of glass and doesn’t include emissions as a result of the gas and electricity used to power the manufacturing plant[22].

We modelled the chemical reaction to produce approximately 12% of the total glass system emissions for the current scheme in New Zealand, based on the same ETS emission factors and using the glass manufacturing facility operator’s 2019 ‘recipe’ for glass. This makes up just under half of the emissions in the from ’Raw Materials’ section, with the remaining 13% produced as a result of virgin material extraction and transport, adding to 23% of the current scheme emissions. This is included in the raw material section of the graph to the right.

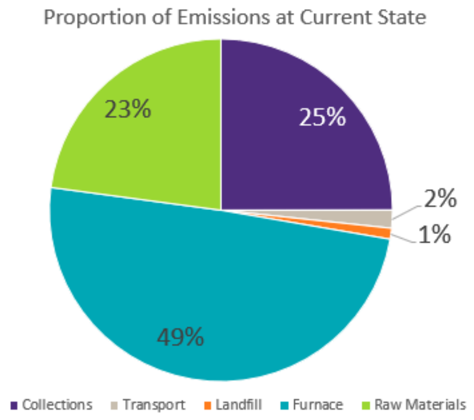
Further increasing recycled glass content would decrease these emissions categories. A hypothetical 100% recycled glass bottle would not release any emissions from combining raw materials, and reduce the amount of gas required, as recycled glass has a lower melting temperature than raw materials.



Schedule	Sector	Activity	Reported emissions (tCO_2e)	Reported removals (tCO_2e)
		Using crude oil or other liquid hydrocarbons	10,621	
	Industrial processes	Producing aluminium	637,130	
		Producing iron or steel	54,431	
		Producing clinker, or burnt lime	470,602	
		Producing glass using soda ash	11,816	
		Producing gold	0	
		Operating electrical switchgear that uses sulphur hexafluoride	5,054	
		Importing hydrofluorocarbons or perfluorocarbons	1,098,438	

Figure 9 ETS scheme emissions extract

Figure 10 Proportion of emissions of glass



Section Summary

To achieve the vision of a more circular economy:

- The proposed scheme will be based on circular principles so that materials and product design out waste and pollution at the beginning of use (rather than end of life recycling limited focus, as proposed by the CRS)
- Utilise the waste hierarchy to maximise the circularity of glass as a resource
- Achieve improved environmental outcomes associated with more low-packaging, reusable, and refillable market solutions.

[21] ETS Participant Emissions, October 2021, https://www.epa.govt.nz/assets/Uploads/Documents/Emissions-Trading-Scheme/Reports/Emissions-returns/Participant-Emissions-Report.pdf

[22] Per a conversation with a glass manufacturing facility operator.

Scheme Design

Introduction

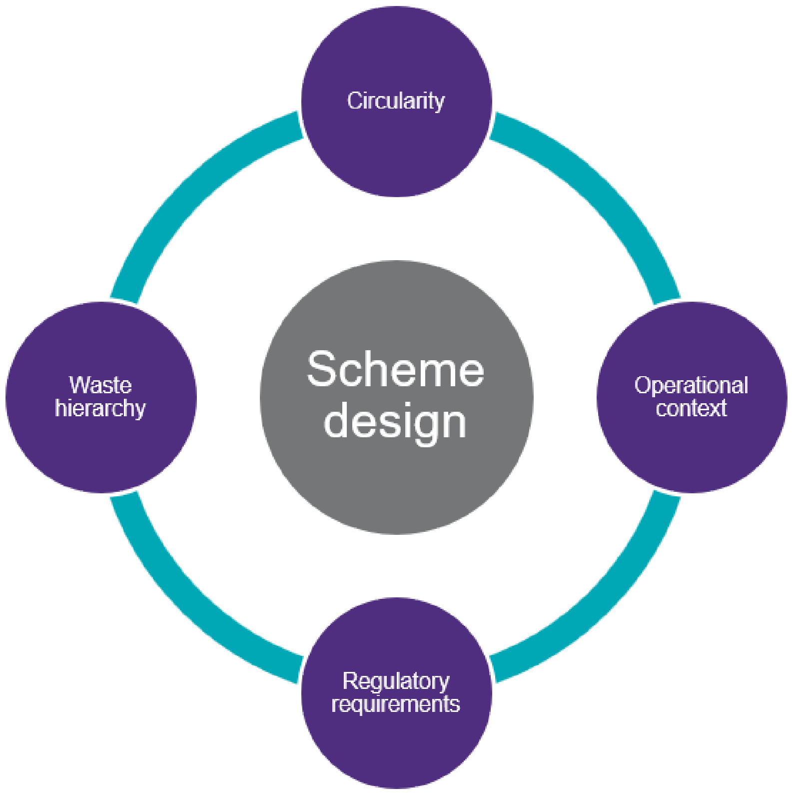
Regulated product stewardship uses regulation to increase circular resource use, planning responsibilities for managing end of life products on the actors in the value chain (producers, wholesalers, retailers, and consumers) rather than on society[23].

In our consultation with industry and the regulator, some principles emerged as the ideal for what a scheme should aspire to, namely:

- A closed loop, circular system
- A low carbon system
- Maximum utilisation of the existing infrastructure
- Encourage greater use of low-packaging, re-useable and refillable solutions
- Placing glass into the highest use when downcycling
- Maximising onshore solutions

In designing a scheme, we have considered the following design considerations

1. What the regulated requirements are for a scheme to be accredited?
2. What are the considerations for a more circular model in the NZ context?
3. What are the operational contexts for a successful scheme?
4. What designs would increase circularity throughout the waste hierarchy?

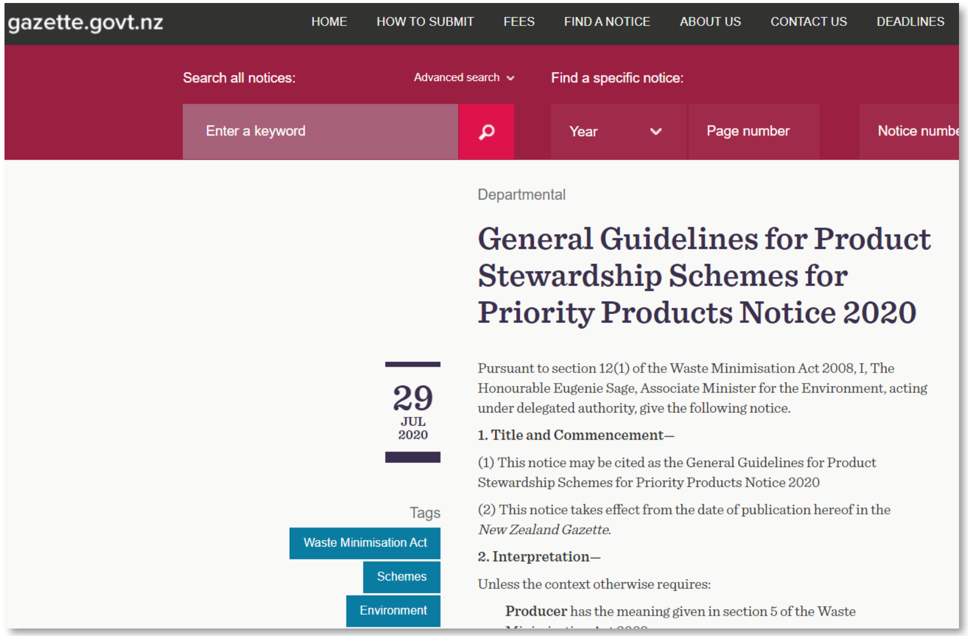


[23] https://environment.govt.nz/what-government-is-doing/areas-of-work/waste/product-stewardship/regulated-product-stewardship/

Design considerations for the regulated requirements of a product stewardship scheme

The Associate Minister for the Environment published General Guidelines for Product Stewardship Schemes Priority Products Notice, gazetted in 2020[24].

In the document the four expected effects of an accredited scheme are outlined and shown to the right.



[24] General Guidelines for Product Stewardship Schemes for Priority Products Notice 2020, https://gazette.govt.nz/notice/id/2020-go3342

1 Circular resource use

- Continuous improvement in minimising waste and harm and maximising benefit from the priority product at end-of-life.
- Increasing end-of-life management of the priority product higher up the waste hierarchy to support transition to a circular economy in New Zealand.
- Investment in initiatives to improve circular resource use, reusability, recyclability, and new markets for the priority product.

2 Internalised end-of-life costs

- Full net costs for stewardship of priority products at end of life met by product or producer fees proportional to the producer's market share and ease of reuse or recyclability of their product.
- Free and convenient collection of the priority product for households and business consumers at end-of-life, including rural populations.
- Collection and management of legacy and orphaned priority products fully or substantially funded by the scheme.

3 Public accountability

- Clear information to household and business consumers on how the scheme works, how it is funded, and how to find the nearest collection point.
- Transparent chain of custody for collected and processed materials, to both onshore and offshore processors, and published mass balances showing rates of reuse/ recycling or environmentally sound disposal of other priority products.
- Publicly available annual reports that include measurement of outcomes and achievement of targets, fees collected and disbursed, and net cash reserves held as contingency.

4 Collaboration

- Optimal use of existing and new collection and processing infrastructure and networks, and co-design and integration between product groups.

Learning from a leader in glass product stewardship - Sweden

Case study – Swedish glass recycling through producer responsibility scheme

Svensk Glasåtervinning (SGÅ) (Swedish Glass Recycling) was founded in 1986 with the purpose to take care of the glass that was up until then collected by Sweden's different municipalities.

In 1994, the law on producer responsibility for the collection and recycling of end-of-life packaging was enacted. The law means, among other things, that anyone who manufactures glass packaging or imports empty or filled glass packaging has an obligation to collect and recycle the glass in an environmentally acceptable manner. SGÅ Swedish Glass Recycling is commissioned to set up a nationwide collection system for glass packaging.

SGÅ is a non-profit company, and its operations are financed by fees from producers and importers and from sales of glass raw material.

The Swedish Glass Recycling Journey

- *Glass packaging is sorted by coloured and uncoloured glass and placed in the designated container in the recycling room or at the recycling station by the consumer.*
- *The glass packaging is picked up by a crane truck and driven to a local warehouse.*
- *The jars and bottles are fed into the glass-breaking plant in Hammar, coloured and uncoloured separately, and crushed there to the correct size.*
- *Out of the plant come uncoloured, green and brown glass crush plus crush of inferior quality. The uncoloured and brown crushed glass is loaded and driven or shipped to glass manufacturing facilities.*
- *At the glassworks, the crush becomes new glass jars and glass bottles. About 40 percent of the new glass packaging will be recycled material.*
- *Most of the green broken glass takes the same path, but some are crushed into grains to become glass wool insulation. Glass shards of inferior quality are turned into foam glass.*

Source: Research undertaken by Grant Thornton Sweden, Sustainability Business Advisory

Over 90% of glass is recycled in Sweden, thanks to convenient kerbside collection, a national producer responsibility scheme and strong social norms established over several decades.

Circular economy is an approach that involves using products that can be reused completely, a so-called cradle-to-cradle approach. In 2018 the Swedish government even established a special advisory group, Delegationen för cirkulär ekonomi (the advisory group for circular economy, link in Swedish), to help make circular economy a key part of government policy.[25]

Figure 11 An electric truck in Sweden collecting a glass community bin

[25] Swedish recycling and beyond

Design considerations for an effective and more circular model in Aotearoa New Zealand

Glass collection is very successful in a number of areas, such as high glass cullet use percentages and high levels of household service. Significant improvements have also been made over the last few years to collections, infrastructure, and end outcomes. Lessons can be taken from known limitations to the Voluntary Scheme with Council collections. We expand on several of these which were key considerations for this scheme design.

The geographic landscape of New Zealand presents a collection challenge

New Zealand is a long country, largely with low population density. There are many rural towns and areas. A focus on standardising a kerbside network could overlook our significant rural regions and population. With urban kerbside service already high, rural collections are an opportunity to increase overall collection rates.

A bottle consumed in Invercargill is a long way from the recycling plant in Auckland. This has led to little end-market value being realised from collected glass by Councils further from Auckland. Additionally, some participants have valid concerns as to whether there are any environmental benefits left after accounting for the logistics emissions from such a long return leg.

A national approach to the design is required to deliver a practical solution that is cost-effective and delivers significant environmental benefit. A comprehensive collections network must also be based on where glass is consumed and where it needs to be collected, including relevant factors in those regions like population density, consumption preferences, and geographical proximity to key infrastructure.

The image below is a visualisation of national glass consumption, based on glass collection data applied to population and household – a first of its kind analysis

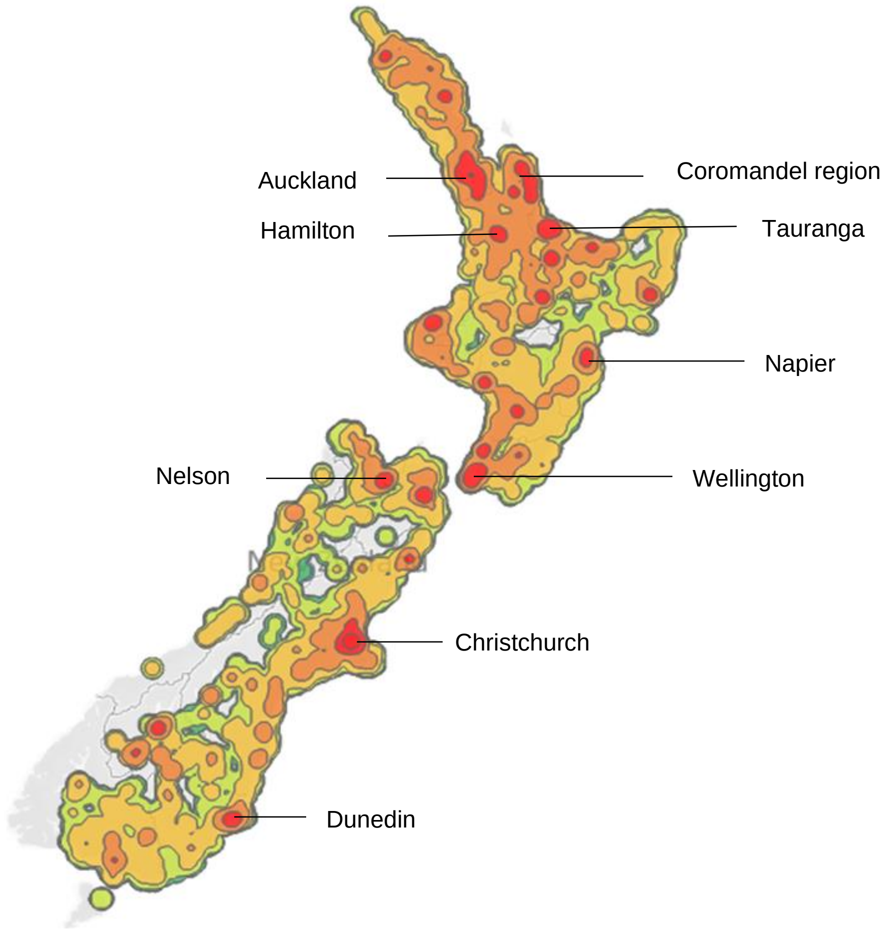


Figure 12 Heat map of glass consumption patterns in New Zealand (Grant Thornton)

Consumption doesn't just occur in households

Glass is consumed by households, commercial businesses, and hospitality venues, and in public spaces/events venues. These groups have different needs and consumption patterns.

All groups should be considered by the scheme to maximise outcomes. Any scheme should be designed with all consumption types in mind to factor in their specific locations, consumption patterns and hence maximise collection.

Seasonality of consumption produces capacity and material flow challenges

A number of regions have highly seasonal consumption of glass over the summer months, and this seasonal trend also exists nationally. This is a challenge because bottle-to-bottle recycling infrastructure requires a consistent flow of inputs for 24/7 production and there is limited storage capacity in the network to smooth flows.

The seasonality challenge presents an opportunity for improved outcomes with a national collection approach and by improving coordination. The network needs capacity to store collected glass and smooth flows throughout the year, providing consistent glass cullet to maximise manufacturing plant efficiency throughout the year.

Statistics NZ in 2021 reported that 31% of Alcohol was made available in the December quarter (Q4), nearly one-third for the total year. With consumption and recycling lagged to this 'available to market' reference point, making December and January the largest consumption months and the seasonal peak collection challenge for glass.

Figure 13 shows collections data reported at the monthly level by Councils. Collection data is a lagged attribute to consumption and influenced by timing of collections – likely smoothing the true seasonality of glass consumption to a degree.

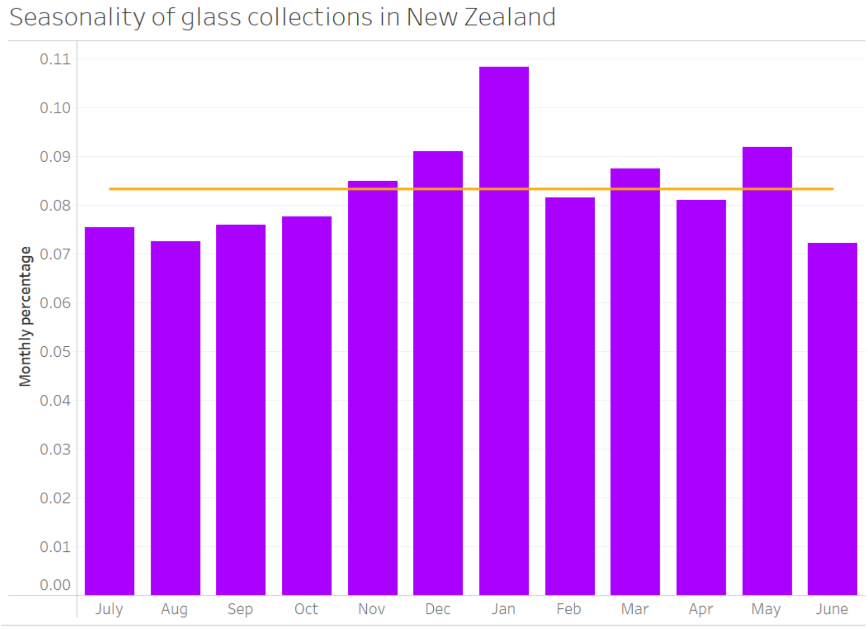


Figure 13 Seasonality of glass collection in NZ (Source Council reported collections data)

Collaboration with end markets is key to delivering better outcomes

End markets for collected glass in New Zealand are a key design consideration for maximising glass circularity. New Zealand has a relatively high proportion of imported glass beverages and products, hence is a net-importer of glass. For example, 16% of beer is imported[26], with the remainder produced onshore. With the one glass manufacturing facility as the only bottle-to-bottle recycler, there are capacity constraints on the amount of glass that can be recycled. Export of glass is costly due to the weight of the material, and this option has largely been viewed unfavourably to-date.

[26] 2021 Statistics NZ Alcohol available for consumption

Because of local processing capacity constraints and transport costs there is a risk that collected glass cullet is downcycled and its full value and potential lost. Designing a glass recycling scheme in isolation will not deliver significant improvements in circularity of glass in New Zealand – it might even reduce it if lower quality glass is collected. The buyer(s) of glass cullet deliver the desired outcomes from collected material, particularly higher bottle-to-bottle recycling. So, the scheme needs to be optimised for maximising key infrastructure like the furnace and ultimately support it to use greater levels of glass cullet.

To maximise circularity of glass in New Zealand, we have worked back from outcomes desired. To increase bottle to bottle recycling, even higher levels of cullet in bottles must be achieved.

This will only be possible by working at a systems level view to collect high-quality, glass fit for going back to the furnace. Higher collections will otherwise have little benefit.

Maximising circularity will require collecting the highest quality material, and minimising losses

Collecting large amounts of material through recycling schemes doesn't deliver benefits directly. High contamination can result in collected material going to landfill, or at least not being kept at its highest use. Losses of up to 40% are experienced by collection networks which have higher contamination, in particular, comingled collection. Other glass-separate collections also have challenges with contamination and rejection of collected material when contamination levels aren't minimised.

Reduced losses mean greater outcomes can be delivered from collected material, reduced volume to landfill and improved circularity of glass.

Minimising contamination should be considered at all parts of the network where contamination can occur and result in losses.

- **Contamination in collection –** this is the largest source of contamination into the system. Collection methods and monitoring should be determined to minimise contamination in collections.

  Contamination monitoring is most effective closest to (or at) collection. Glass bins with lids collected with automated mechanical arm collection have less contamination monitoring and therefore higher contamination and losses than comparable open-top bin collections.

- **Transit / contamination** – separated collection and facilities designed for glass collection and aggregation (Hubs) are important. Multi-purpose trucks and deteriorating bunkers without large aprons can introduce gravel contaminants and reduce the value of high-quality collections.
- **Rejection loss** – contaminated collected material can be rejected by the end-market, so quality checks along the supply chain are integral to minimise this loss and maximise outcomes and value.
- **Processing loss** – this is significantly reduced when glass is free from contaminants, and more so when colour-separated.

Maximising the quality of the material delivers the highest value outcomes

The value of collected cullet to a furnace is largely influenced by the level of processing required for it and the degree to which it can substitute raw materials used in glass manufacturing. Processing costs of low-quality cullet can increase hugely compared to quality cullet low in contaminants. Mixed glass processing costs are in the order of 50% higher and co-mingled collection 150% higher[27].

Colour matching of cullet to production runs results in higher cullet volumes able to be used in producing new bottles before visible colour distortion. Current levels of glass colour-separation is a key reason new bottles produced in New Zealand are already high in recycled content by international standards.

The higher the quality of collected material and colour separation to match production, the greater amount that can be used in bottle manufacturing. Improvements in quality and cullet levels will result in additional value being realised by the collected material and reduction in scheme net costs.

[27] Personal conversation with Beneficiation plant operator

Design considerations for Scheme operation

Our challenge has been to design a scheme with effective governance, a sustainable commercial model and a technical cycle that is practical for the New Zealand context. We firstly consulted widely amongst industry, with peak bodies and local and central government. We also examined schemes in other jurisdictions to understand the key success factors. One of these interviewees neatly summarised how a scheme needed to be multi-dimensionally sustainable[28]

- Operationally
- Financially
- Technologically
- Socially
- …before being Politically and then
- Environmentally sustainable.

Below we outline our views on governance, commercial and technical parts of the scheme design.

Constitution and governance structures

In our consultation there was practically unanimous support for two main ideas

i) A governance model that represents all the actors in the value chain which requires support for the model to be implemented.

ii) Data that is transparent, verifiable, and trusted.

The most recent Australian Schemes (Queensland and Western Australia) are illustrative of these principles.

Almost all of the people we spoke to support the idea that the scheme operator should be a not-for-profit with a clear purpose. Most of those consulted supported the idea that representation of all the actors in the value chain was vital, giving a seat at the table and hence voice to manufacturers, logistics providers, recyclers and preventing dominance from any one part of the value stream, and also creating sufficient numbers to be able to prevent conflict of interest influencing award of operational contracts and investment decisions.

Trusted data was also mentioned by many of those we consulted with, as it forms the basis for payment and also the key mechanism to prevent scheme rorts. Audits were also seen by many as being required for a successful scheme.

Commercial structure

Our consultation highlighted the risk to a scheme if it over or under-recovers fees. In the first situation the scheme operator can end up with a large surplus from non-returns, which presents several issues. Either the operator must return surplus to the industry with an apology, or customers complain of being overcharged.

People spoken to felt it is essential for the scheme to be informed by people who really understand the materials and unit operations in the various steps.

Interviewees provided us with a range of views on commercial structure. We have synthesised some of these common principles here:

- Industry should pay on all containers
- No cross subsidisation of recycling divisions or between products[29]
- All fees paid in arrears and based on monthly actual data – therefore need a scheme float[30]
- No free riders

[28] Interviewee – personal communication.

[29] This is not a challenge in an EPR (or similar) scheme focused on a single resource with uniform recycling process

[30] We note that achieving this level of data and declaration was a challenge for some in Australia

Technical structures

Our scheme design has been informed by detailed discussion with many of the actors in the value chain for glass including producers, logistics companies, end users and waste management and minimisation organisations. Important constraints such as NZ's geography and location of key infrastructure including the furnace, existing beneficiation and existing capture and storage (such as bunkers) have been considered.

The scheme design seeks to reduce the use of single-use bottles, encourage refillables, increase glass collection rates, increase the percentage of cullet in remanufacture and when the material can no longer be returned to the cycle, prioritising the use of the waste glass into applications of the most benefit to NZ.

Levy applied to weight of glass

As we were designing the scheme, we considered both applying the levy to count of bottles, or to weight of glass.

CRS levies (including the one proposed in New Zealand) are commonly applied to the bottle. Internationally there are examples of both methods for Producer Responsibility schemes and so we considered the practical application as well as the incentives each option would provide. Our objective being a fair application that also incentivises producers to make decisions that support lower emissions and more circular outcomes for New Zealand.

Applying a flat levy to each bottle could be considered unfair to smaller bottles as they pay the same levy as a bottle twice the size. For this reason, levies are commonly applied to size categories. Internationally this can be between two and six or more size brackets. The same levy is applied to each bottle within a size category. The challenge with this remains that some bottles would just scrape into an arbitrary grouping, or just miss out. Category definition and applied levy would also be subject to selective lobbying.

Applying a levy based on weight incentivises more efficient use of materials.

Additional consideration was given to the levy being based on the packaging's impact on, and cost, of recycling. Certain bottle shapes and label types increase processing costs and losses.

Some product stewardship schemes have transitioned from applying levies per bottle, to per weight, such as in Sweden.

We therefore propose a levy applied per kilo of glass to market.

Summary of levy application

The levy must internalise end-of-life costs of glass, meeting full net costs for stewardship through fees proportional to market share and ease of recyclability.

Therefore, key principles of the proposed levy include:

- Cover net costs to recycle glass
- Internalising the externality currently paid by society
- Including offsetting negative impacts of litter
- Incentivise up the waste hierarchy, including encouraging refillable large vessels, and refillable containers over single use bottles, and bottles with higher recycled content
- Incentivise less resource-intensive products

Based on our analysis of the net costs of the scheme, the levy would decline over time as initiatives that reduce the total cost of the scheme are implemented and change has been embedded. This calculation is detailed in a later section.

Levy supporting scheme objectives through Eco modulation

Eco-modulation of the levy rate was considered in many forms: based on the circularity of the bottles, ease of recycling or a standard vs nonstandard bottle definition set.

We concluded that defining the non-standard criteria was impractical due to the varied glass in scope of the product stewardship scheme. Further, large variation or complex calculations of the bottle's circularity could be too much of a leap from the current state and potentially disadvantage smaller producers.

We are proposing two key variations in the levy, which are expected to offset each other over a five-year period.

1. Refillable containers receive an 85% *lower* levy than the headline rate
2. Bottles sold into market not meeting recycled content targets receive a 20% *higher* levy than the headline rate.

The first is designed to encourage current and future refillable initiatives – while still acknowledging it is the same glass resource used, and there remains a recycling burden once refillable bottles are cracked or at end of life.

The second is designed to encourage individual beverage/food producers to demand high recycled-content glass containers, in line with the scheme target that year (increasing over time). This is to meet the real additional cost to the system of recycling low/zero recycled content containers, but not so high as to price these bottles out of the market. The additional cost for a single beer bottle of 0.222kg weight would be just 0.89c.

This higher levy we expect will particularly be relevant for producers bringing glass containers into the New Zealand market. It will incentivise importers to work with suppliers on bottle composition, or to shift to a bottle manufacturer able to deliver higher recycled content. The scheme's future recycled-content targets will be hard to meet for some manufacturing facilities currently using lower levels of recycled content in bottles, however we are expecting other markets to move in the same direction on recycled bottles, collectively encouraging container manufacturers to increase recycled content.

As imported glass containers have a significantly higher emissions profile than local production, this higher levy will also support a shift to regions (on-shore or near-shore) with lower emissions involved in getting containers to the New Zealand market, and consequently support a reduction in the system-level emissions for the New Zealand glass market.

Glass in Scope

Glass in scope includes container and bottle glass manufactured locally and overseas and sold in New Zealand. Specifically, Soda-lime-silica glass.

This is consistent with the type of glass produced by the current voluntary scheme members, and that able to be recycled in the local glass manufacturing facility.

Glass out of Scope

Glass and similar products that are not a bottle or glass food container are proposed to be excluded from this scheme. Borosilicate glass containers are also proposed to be out of scope.

For example, light bulbs, fluorescent tubes, Pyrex dishes, glass ovenware, china and crockery, window glass, laboratory glass containers, TV tubes and computer screens.

This is for two main reasons:

1. Recycling processing, mechanisms and end markets are vastly different, which exponentially increases the cost of inclusion of these materials
2. Producer markets are very distinct, leading to limited value in industry collaboration.
3. With the exception of flat glass, these products and items are contaminants in the recycling process, increase losses and processing costs (decreasing the value of collected material).

Exported finished goods in glass containers are also proposed to be excluded as these will not be recycled in New Zealand and may pick up a similar levy in the importing country.

Designing to increase circularity throughout the waste hierarchy

A CRS provides a financial incentive to collect and return glass, however it is still limited in design to being a recycling scheme – falling well short of achieving the significant improvement in circularity of glass.

The product stewardship scheme has a series of initiatives higher up the hierarchy (summarised in Table XIII and detailed below), including initiatives to improve circular resource use over time. These have been designed consistent with the Priority product guidance on circular resource use, specifically:

i. *Continuous improvement in minimising waste and harm and maximising benefit from the priority product at end-of-life.*

ii. *Increasing end-of-life management of the priority product higher up the waste hierarchy to support transition to a circular economy in New Zealand.*

iii. *Investment in initiatives to improve circular resource use, reusability, recyclability, and new markets for the priority product.*[31].

Reduce Single Use Bottles

Encouraging reduction of single use bottles is the first level of the waste hierarchy and hence has the most significant potential to improve the circularity of glass in New Zealand. At the top of the waste hierarchy, reduction of the overall glass to market, in particular imported glass which has a significantly higher emissions profile, is desirable.

Hospitality

Currently 10% -15% of single use glass containers are consumed at hospitality venues, an area where recycling is currently low. While improved collection from hospitality venues is a valuable initiative, many beverages at these venues already have significantly more circular packaging alternatives available.

Glasses and handles are the smallest circular loop, with the return-leg only going as far as the steriliser in the kitchen. Keg and pour solutions are effectively operated throughout the country, for beer and cider of all varieties.

Where the alternatives exist, we support a phase out of single-use bottles in hospitality venues, in favour of keg and pour and tap systems, which are both the lowest emissions packaging option, and highly cost effective.

Introducing a mandatory levy on single use bottles will incentivise venues and customers to move towards taps. There is no levy on kegs or tap systems, so hospitality could be encouraged to create space for more taps and reduce single use bottles. This is a much more circular solution for beverage packaging as the kegs can be picked up by producers to be refilled and reused again and handles sterilised at each venue.

A keg and pour system already operates in most New Zealand bars and venues. The number of beers and ciders on tap differs significantly between venues, many have a combination of bottles and tap for the same range. Producers have a strong influence on SKUs sold to venues, so producer support for reduction of single-use bottles in hospitality is essential. We note that there are some practical limitations that will need addressing such as limited space in some locations, and that the current 50L kegs might be too large for some lower volume beers.

This shift could benefit the whole beverage industry, improving margins and creating a unique consumption experience to at-home consumption. Many avid beer drinkers also consider tap beer superior in taste due to reduced contact with air and light.

Without a shift to keg and pour systems, significant improvement in glass recycling at hospitality venues would be required to increase glass collections. Glass recycling collection by colour should be arranged by all venues, supported by producers. Phasing out many single use bottles at hospitality venues would then reduce the effort of separating bottles, storing empties and recycling.

The venue pictured below has replaced fridges where glass bottles would typically reside to provide space for additional kegs, tapped through to a wide range of handles, still giving customers a large variety of options.

[31] General guidelines for Product Stewardship Schemes for Priority Products Notice 2020, Gazette.govt.nz

Venues

Event industry trends have been moving significantly away from glass at events and event venues primarily due to health and safety concerns. There is an opportunity to advance this trend to avoid all glass sales of single use glass bottles for beer, cider and non-alcoholic beverages at events and event venues.

This would further promote health and safety, decreasing the glass to market and reducing litter to landfill. Suppliers should support venues with appropriate sustainable delivery packaging alternatives, in the form of venue return cups, customer keep-cups, paper or other sterilisable containers.

Figure 14 Craft Embassy tap beers (Christchurch)

Encourage refillable containers

Refillables are high up the waste hierarchy and a significant opportunity to increase circularity of glass. Many of the industry groups and regulators we spoke to considered refillables have a vital part to play. We have considered how a product stewardship scheme might encourage glass refillable solutions to start to operate.

Local refillable solutions deliver the most circular outcomes, and ease of local collection can work well, and historically have done so. We note that it is likely not a panacea for NZ as a national solution, however it makes sense in rural regions and where there are local

Table VIII Reduce glass to market target and initiatives

Initiative	Year one target: Reduce Glass to Market by 6.5%[32]	Year three target: Reduce Glass to Market by 12.5%	Year five target: Reduce Glass to Market by 15%
Introduce levy on single use bottles	6.5% decline in demand for single use bottles	-	-
Phase out single use beer and cider glass bottles at hospitality venues (only on hospitality beer and cider)	Mandatory Levy on single use bottles discouraging stocking and consumer selection.	Double the levy on all single use beer and cider bottles	Triple the levy on all single use beer and cider bottles Double the levy on all single use non-alcoholic glass bottles
Mandatory colour-separated recycling at hospitality venues, capturing hospitality volume going to landfill	Colour separated collections must be arranged by venues. Extra effort rewarded with no dumping fee. Extra effort incentivises keg & pour over single use.	-	-
Encourage low-packaging alternatives	No levy will be applied on keg & pour systems. 85% lower levy applied to refillable glass bottles. Promotion and advocacy of low-packaging alternatives from single-use bottles.		
Events	Advocacy of low packaging alternatives to single use bottles	Support ban of single use glass at all events and stadiums	-

[32] We have used the same projections as CRS Financial modelling to allow like for like comparison.

products available. The two main obstacles to refillables currently in NZ are a lack of standardisation and regional wash and refill infrastructure.

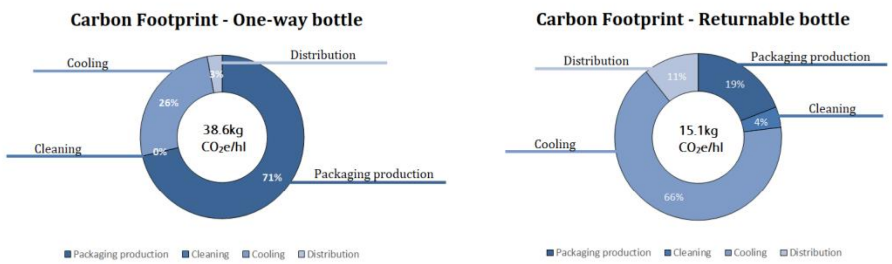
New Zealand currently has a very low percentage of refillable containers in the market. The ABC Swappa Crate is the only scheme operating at a national scale. New products traditionally packaged in flint bottles have had recent success in ABC's refillable crates.

A key part of the ABC model is the collaboration between manufacturers with a standardised bottle. Indeed, the industry has been collaborating since 1920 when 11 brewers formed ABC. Formats have included quarts, pints and stubbies over the years. Standard bottles can be washed and refilled by either party and reused as many times as possible. Long run data from Sweden shows average re-use of their 33cl bottle is 40 times[33]. Various other countries have also utilised bottle standardisation and collection and re-use collaboration to great effect, either by legislation or by voluntary industry co-operation (Sweden's began in 1885)[34].

Recently Coca-Cola France announced its commitment to making standard bottles without labels so that they can be returned and refilled and used across many of their brands which will be distinguished from each other by label and decoration, and not by bottle shape.

In order for more refillable solutions in NZ, or expansions of existing solutions, there are several issues to consider including reweighting some specifications[35], creation of pools of bottles[36], bottle washing and sterilising capacity, solving the issue of sticky labels[37] and changing consumer perception[38]. All of this requires technical work, probably standardisation of format and investment in equipment.

Figure 15 Lifecycle assessment of a single use bottle and a refillable bottle



Refillables are higher up the waste hierarchy. The lifecycle of a refillable bottle has 60% lower emissions, or 83% when considering all lifecycle phases outside of cooling.[39].

Refillables also lend themselves to more local solutions (and hence employment).

The graphs in Figure 15 display the breakdown of emissions from one use of a one-way and refillable bottle in the Netherlands (no comparable NZ lifecycle study). The use of a refillable bottle distributes packaging production impacts over each use of the bottle, so it is significantly lower per use than a single-use bottle. The cooling segment of each chart relates to the chilling of the final product in storage or transport and is out of scope for our analysis.

[33] https://ec.europa.eu/environment/pdf/waste/studies/packaging/sweden.

[34] ibid

[35] The industry has also been optimising for transport for some time. Single use bottles have been being made lighter with less materials and reducing emissions for transport. Moving to more reusable bottles would require re-weighting some specifications agreed to as industry standards in order to optimise for reuse.

[36] In order for a scheme to work, the creation of pools of bottles 2-3 times the size of the number being sold is required, along with a collection system – many other countries use a returnable plastic crate as part of the system.

[37] Labelling has evolved in recent years, with ultra-sticky synthetic glues being favoured by many beer brands. These glues and plastic labels are not suitable for refillables and increase processing losses in recycling as they are not easily separated. However, solutions exist. Historically many labels were affixed using casein glues derived from dairy. Immersing the bottles in a solution with a moderately basic pH results in clean label separation. We note there are requirements about how alcohol labels must remain affixed when submerged in New Zealand.

[38] Another challenge to overcome is the look and perceived value specific to the bottle itself. Brand can design the bottle to give the customer perception desired. A customer in a restaurant typically expects their beer bottle to look new and clean when served – a bottle that has been reused multiple times, although clean, looks worn and many brewers have struggled with this presentation.

[39] Reducing the carbon footprint of glass packaging in the beverage sector in the context of consumer convenience, 2019

Should refillables be included, considered, or kept completely separate?

The current design excludes design of a refillables scheme, a significant exercise in and of itself.

That said, a Product stewardship scheme should manage end-of-life outcomes for the glass resource shared by single use bottles share and refillable glass containers.

As refillables are higher up the waste hierarchy, the scheme should embrace refillables as a preferential container form.

As this is an area with considerable technical work to do, along with the modelling and financial analysis – which is outside our scope – we have taken an approach of getting the incentives right, then allowing the expert stakeholders in the space to engineer the right solutions, be they localised or national.

The compelling business case for refillables including infrastructure, format and standardisation decisions and optimal radii is a substantial piece of work in itself and has yet to be completed. The current design excludes design of a refillables scheme and whether it could or should be managed by the product stewardship scheme.

Localised solutions have significant potential to contribute to reducing reliance on single use packaging. Particularly bring-your-own-container options, which avoid transportation and logistics networks of refillable containers.

In considering the relative benefit of a regulated product stewardship scheme this inclusion would make comparability difficult to the current state and proposed CRS.

For these reasons we have not recommended to include funding and operating of refillable network into the scheme.

Therefore, to support the growth of refillable solutions (in whatever form) and consistent with its lower cost to society of recycling, we have proposed an 85% lower levy for refillable glass containers.

Case study – refillable scheme with each bottle used four times a year

ABC supplies new and recycled bottles/crates to DB and Lion breweries to the factory gate. Breweries undertake bottle washing onsite and undertake quality inspections.

ABC collects all empty crates from the wholesalers and refunds the deposit to wholesale, retail, and hospitality customers. ABC's average recovery rate is 90%, each bottle four times a year and lasts 10 years – meaning up to 39 single use bottles can be avoided. Where refilling leads to the use of less material for bottles, less energy is needed to extract raw materials and manufacture new bottles. Energy used in washing refillable bottles is more than offset by savings in energy needed to make additional new bottles.

Key features:

- *Standardised heavy-weight bottle*
- *Easy label removal*
- *Standard cleansing and quality assurance procedures*
- *Effective collection network*
- *Deposit*

Sources: Associated Bottlers Co. Sources: Associated Bottlers Co. Ltd, sourced from Marlborough.govt.nz

Case study – reusable container network

Again Again is trying to make a convenient way to make waste-free takeaways the new normal. With its app, consumers can access containers that vendors make available for their food, beverage, and grocery offerings. Borrowing is free to the consumers; vendors pay on a per-use basis that is comparable to single-use packaging.

Vendors have complete choice over the containers, able to select containers from Again Again's serviced fleet, or they can be procured elsewhere. The system has had success in Coffee cups, Food trays and bowls.

The system could be leveraged to support lower packaging for food and beverages typically packaged in single-use glass.

Source: Sustainable Business Network, Circular economy directory - Again listing

Increase the collection rate

Hospitality

Hospitality presents the largest opportunity for improvement of glass recycling. Currently 10-15%[40] of single use glass bottles are consumed in hospitality settings, where the outcome is usually landfill as it is the cheapest and easiest method. By targeting hospitality for an improved collection process, the glass collection rate could increase by up to ten percentage points.

We propose that hospitality venues become responsible for separating glass collections from general refuse and other recycling. The scheme would support the hospitality sector with best practice and learnings and support collection providers not already providing glass collections. While some additional effort would be required in sorting, the scheme would provide zero-cost drop off locations for these commercial collections.

Material business disposal costs could be avoided through waste diversion

Up till June 2022 the Waste levy was $10 per tonne, this is increasing over time to $60 per tonne in July 2024. Glass diversion would disproportionately provide cost-savings, as the waste levy is applied by weight and glass is a heavy resource. The weight of glass would contribute to a significant (and increasing) portion of the waste levy passed through to businesses for any businesses not separating glass from refuse.

Urban households

Colour-separation at source is widely accepted as the best practice method for collecting the highest quality cullet. Three Councils that have recently shifted to this method have also seen an increase in quantity collected, ranging from 21% to 38% year on year[41]. Most Councils already operate with glass separate bins at kerbside, allowing for a relative continuity of service and easier transition for residents than to a CRS approach.

The CRS attempts to incentivise people to travel away from home to collect a refund for bottles consumed at home, leaving other glass such as those used for food packaging to be collected at kerbside. Remaining glass (either non-bottle glass or bottles from non-participation categories) presents a recycling challenge for Councils as the small volume of glass left contaminates other material (and vice versa).

The kerbside collection network is already successful in the majority of regions and is popular with residents due to the high convenience level. Key regions where improvement is required are comingled regions, including the metropolitan regions of Auckland and Christchurch where a single bin for comingled collection is used. Introducing glass separate bins in these regions would deliver up to 15% - 25% improvement in collection rates in these regions[42].

We propose the scheme transitions to operating a national urban kerbside network consisting of:

- Colour-separated at source glass collection with fortnightly collections
- Open-top bins or crates of up to 45L in size - supporting contamination monitoring at-source, while balancing handling weight

This means that all glass consumed at households can enter the recycling system and contamination can be minimised. This easy-to-understand system for consumers will result in high participation rates and reduce contamination.

[40] Personal conversation, industry estimate. No reported data covering all glass types available

[41] GPF 2022 Accreditation report

[42] Author's conservative estimate based on loss in these regions and increased collections with comparable transitions

Rural communities

While colour sorting at kerbside is the widely accepted best-practice method for collecting the most material with the least contamination, New Zealand's widely spread population means that it is not feasible to service every household. The solution, which is currently in place in many rural communities, is community recycling centres.

These drop off points are at central locations making drop offs as easy as possible for the rural community. The largest rural networks consist of unmanned drop off points. These are the best option for wide coverage of rural communities where kerbside service is simply infeasible and in areas too small for a manned service centre or aggregation point.

We propose the scheme works with Councils to transition existing sites and establishes the remainder of a national rural community drop off network consisting of:

- Colour separated bins in each settlement or town nationally (see Figure 16)
- Larger towns receiving multiple community collection locations.

Figure 16 Marlborough District Council Rural Community Recycling

Public Spaces

A key concern and target of the CRS is to reduce the litter in public spaces through the financial incentive of the deposit amount. While much litter impacts the environment negatively, glass does not negatively impact the environment due to its non-toxic, neutral, non-reactive composition. The negative impact of glass is limited to the negative perception of it. Discarded glass, like all forms of litter is visible and unsightly. Glass, when broken, can cause injury.

A recent survey found that 50% of consumers would not walk more than 20 meters to find a recycling bin (62% won't walk more than 40 meters)[43]. This means that unless consumption is highly concentrated in an area, recycling bins would need to be placed at a very high frequency to deliver improved collection outcomes.

In the same survey consumers were asked which collection method suited them best:

- 73% preferred kerbside collection
- 14% a return scheme and
- 13% preferred recycling bins in public spaces.

This supports collection evidence that most of the glass consumption is at the household, followed by hospitality venues, and consumption in public places is a low percentage. Liquor bans in public spaces and glass bans at events are also positive trends for glass consumed in public spaces, and consequently, glass litter.

While littered bottles are a very small percentage of total glass to market, there is a negative externality to society from those who consume glass bottles. The volume of glass bins required to materially decrease litter would be exceedingly large and expensive, and therefore we are proposing the scheme targets social norms of litter and litter clean-up.

Communities with the least litter are those in which littering is not socially acceptable. New Zealand has a way to go on this. The recent packaging survey found that 24% of consumers would do nothing if they saw someone littering. Therefore, we propose a marketing budget that supports campaigns to reduce littering and encourages recycling.

To combat remaining litter (and existing levels) we are proposing a $350,000 annual contestable fund to support litter collections, administered by the Managing agency of the scheme.

We would also recommend advocating for additional regulatory action on littering. This could be in the form of fines for litter, as is seen in Singapore. A regulatory response could precede a societal shift towards litter being not acceptable.

Table IX Increase collection rate target and initiatives

Initiative	Year One Target: 80% collection rate of glass	Year Three Target: 85% collection rate of glass	Year Five Target: 90% collection rate of glass
Hospitality collections	Mandatory glass collections at hospitality venues (with grace period)		
Household - Introduce glass separate bins to all urban regions	Glass Bins in Auckland (2-year phased approach)	Glass Bins for other Districts currently with co-mingled collections	-
Household - Introduce colour Sorted at source to all kerbside regions			All kerbside collections Colour separated at source
Rural glass collection access	Rollout of rural collection points, increasing convenience and access		
Litter collections	$350k p.a. contestable fund to groups undertaking litter collections, ensuring glass collected is colour separated		

43 Horizon Research, Packaging survey, March 2022

Increase of glass cullet used in new bottles

Glass can be infinitely recycled. Therefore, the highest percentage of glass cullet possible should be used in production. This leads to a three-part reduction in furnace emissions.

1. The requirement for virgin material extraction and transportation is reduced
2. Glass remelts at a lower temperature than virgin materials, reducing energy input
3. Use of glass cullet avoids the chemical reaction from combining virgin materials which releases carbon dioxide.

To increase the percentage of glass cullet returned to the furnace, there needs to be a greater supply of higher quality cullet. Any glass that enters the furnace first must go through a beneficiation plant. Higher quality cullet requires less processing at beneficiation, resulting in cullet readily available for input into the furnace. The less contamination present in the cullet, the greater value of the collected material and ability to offset costs of collection.

Table X Increase recycled content target and initiatives

Initiative	Year One Target: 72% recycled glass in bottles	Year Three Target: 85% recycled glass in bottles	Year Five Target: 90% recycled glass in bottles
Colour separate kerbside collections increasing quantity of quality cullet	Glass Bins in Auckland (2-year phased approach)	Glass Bins for other Districts currently with co-mingled collections	All kerbside collections Colour separated at source
Influence market demand	Advocate producers to demand higher-cullet bottles	Double levy on any bottle produced with lower cullet levels below the target	Double levy on any bottle produced with lower cullet levels below the target
Deliver consistent flow cullet to furnace	Through building in additional capacity in the network at aggregation points and collaboration with the Furnace, supply cullet in line with demand requirements consistently throughout the year		

To increase the efficiency of the beneficiation process, increase the capacity and lower the emissions, the scheme would prioritise collecting the highest quality glass, and return the lowest cost cullet to the furnace. The scheme would also prioritise glass-out bins for kerbside recycling and motivate beverage producers to collect from hospitality venues. Educating New Zealand's consumers on the importance of clean and separate collection will enable the increase of scheme targets under a product stewardship scheme.

Case study – 90% cullet bottle

In 2019, DB Breweries and O-I Glass produced a 90% recycled content flint beer bottle using high-quality recycled glass (cullet). Flint bottles produced in New Zealand typically contain around 45% recycled content. This is in part due to the availability of high-quality cullet, but also in-specification colour requirements for premium, consumer-facing flint glass bottles.

This initiative demonstrates that with good quality cullet in place, we can produce a bottle with reduced environmental impact while meeting container integrity and in-specification colour requirements. Quality was not compromised in any way, and the bottle could withstand production and product safety processes. Importantly, the initiative saved over 800,000 kg of CO2e when compared with imported virgin glass bottles and led to a 45% increase in recycled glass content for 10 million bottles.

Reducing contamination to improve quality

Contamination introduced through the network increases the cost to process and decreases the value of collected material. Reducing contamination will minimise losses of collected material and maximise benefit.

Large losses can occur from collections, logistics, rejections, and processing and can materially decrease remaining volume available for bottle-to-bottle recycling (Figure 17). Minimising contamination should be considered at all parts of the network where contamination can occur and result in losses.

In our consultations, many experts made clear to us that reducing contamination is critical for any scheme that looks to maximise circularity and reuse. Whether for containers to be washed, sterilised, and re-filled, or when the glass drops down a cycle into cullet for remanufacture, keeping the glass clean is an imperative to keep it at its highest use.

Areas where losses can occur throughout the system

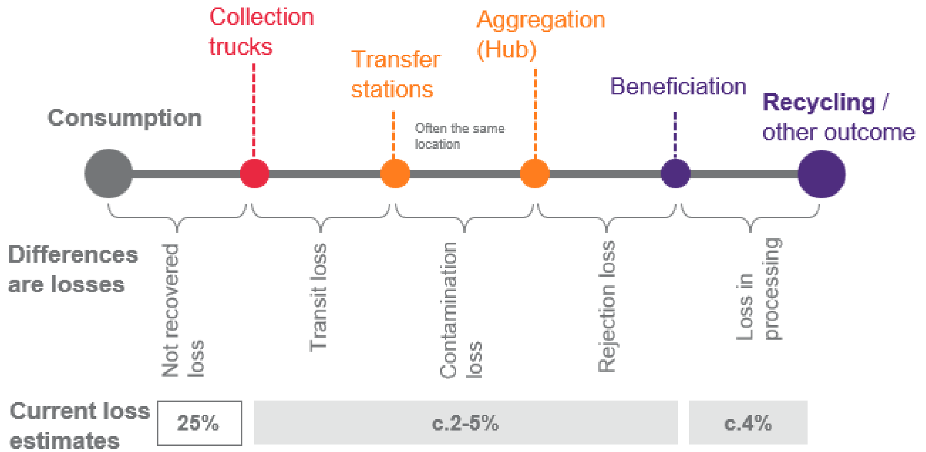


Figure 17 Current losses, Review of glass cullet data collection methodology 2021

Minimising contamination at collection

Currently there is often confusion on what can be recycled, and what cannot. A key reason for this is the disparate approaches taken by Councils. This varies from what materials are collected, the collection method, to recommendations on how to recycle. For example, Council advice differs on whether to crush containers or to leave caps on.

A national approach with consistent messaging will reduce confusion on what can be recycled and how, resulting in lower contamination, lower processing costs and lower losses.

Collection with the contamination monitoring at source is proven to have the lowest levels of contamination and lowest costs of processing. Real-time feedback in the form of specific notes about recycling contaminants has effectively been used by several Councils to encourage recycling behaviour change in specific households. We understand that this form of real-time feedback, coupled with rejection of contaminated recycling at kerbside delivers behaviour change ‘really quickly’. This form of feedback is more targeted, and will be more effective, than contamination monitoring later in the system or broad sweeping marketing campaigns.

Real-time feedback is the most effective at delivering behaviour change and is also the most effective contamination reduction method, significantly reducing subsequent monitoring and processing costs and maximising the cullet value

A national kerbside scheme also has the benefit of seeing wider trends and implementing campaigns on what can be recycled to prevent contamination before it happens. Key products of confusion that cause contamination of glass collections are: light bulbs, fluorescent tubes, heat resistant glass and crockery. The most damaging contaminant for glass manufacture is pyro-ceramic or heat resistant glass[44].

[44] Private conversation, Visy

As New Zealand has shifted towards broad support for recycling, a new challenge of consumers recycling non-recyclable material, commonly referred to as 'wish-cycling' becomes a significant one in reducing contamination (Table XI).

Our scheme design is based on best-practice collection methods which minimise contamination at collection – the largest area of contamination introduction into the system.

Key attributes of this design are:

- Glass-separate collections at kerbside
- Collections in open bins or crates
- Contamination monitoring at source
- Colour-separation at source.

Types of recyclers in the population

Table XI Different types of recyclers[45]

Category	Type, attributes, and behaviour	Policy response	Relative size
Litter bug	Doesn't recognise the importance of recycling or waste disposal. Contributes to contamination, loss or recyclable material, and litter. Unlikely to respond to education or improved systems but will if incentives are strong enough	*Incentives - tax and subsidy*	
Indifferent recycler	Doesn't recognise the importance of recycling but does not litter. Might use whatever bin (rubbish or recycling) is convenient. Contributes to contamination and loss of recyclable material to waste. Needs education to understand importance of recycling	*Education*	
Reluctant recycler	Understands the importance of recycling but inconveniences are seen as significant. Could be an effective recycler if the system were minimally inconvenient. Likely to resent being forced into a more inconvenient solution	*Simple and easy access collection systems*	
Wish-cycler	Enthusiastic and well-meaning. Would be an effective recycler but doesn't understand the system. Potentially the worst offender for comingling and contamination. Needs clear, easy to understand information	*Information*	
Champion recycler	Understands the requirements for well-sorted, uncontaminated recycling. Uses systems effectively. Limited by system constraints, e.g. comingling collection, infrastructure constraints	*Improved collection and recycling systems*	

45 NZIER, sourced from GPF 2020 accreditation report

Minimising contamination in return network

Contamination can be introduced throughout the network if systems and processes are not designed to reduce contamination.

Two common examples of contamination introduction in the network are:

- Bunkers in disrepair or without sufficiently large aprons can introduce gravel and other contaminants into cullet being stored
- Trucks or containers that haven't been properly cleaned can introduce gravel and dust into cullet being transported.

Because of this education of collections and processing staff throughout the network will be important so they are aware of contaminant risks and actively mitigating these.

Bunker infrastructure in New Zealand has been improving, but further investment is required to provide the capacity required of sufficient quality bunkers. This is a key area of capital spend expected for the Managing agency to be contributing to, alongside Councils, or owners of transfer stations operating as Spokes or Hubs.

Rejection loss

Rejection losses occur when collected volume begins its journey to the glass furnace but is turned away at a monitoring step because of contamination levels that are too high. This volume can eventually go to a lower-value end application, but regularly ends up at landfill.

This problem is currently compounded by the ownership of the collected cullet. If glass travels from Central Otago to the Christchurch Hub and gets rejected, the Council is responsible for addressing the contamination or receiving the glass back. A new national Managing Agency would be responsible for activity in collections and aggregation points and can address contamination at any point before sale to the end market.

Minimising losses in processing

Losses in processing are a function of quality of glass arriving at the furnace and minimising elements that separate poorly from glass and are harder to identify.

Highest losses will occur from highly contaminated comingled collection (Figure 18). Mixed glass will also be slower and result in higher processing losses than glass colour-separated at source.

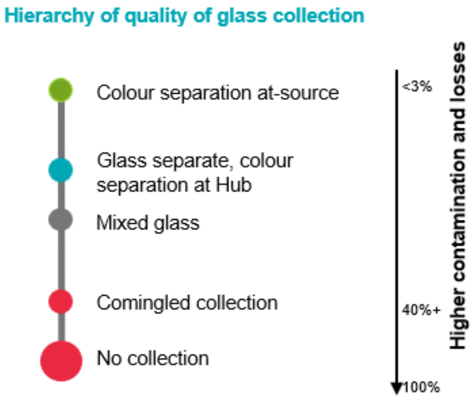


Figure 18 Hierarchy of glass contamination by collection type

Other elements affecting levels of loss in processing are:

1. Non-container glass contaminants of similar form e.g. ceramic, porcelain
2. Non-container glass contaminants of different form e.g. gravel, chicken bones
3. Ultra-sticky labels
4. Caps and lids
5. Unusually thick bottle parts e.g. deep bottoms of some champagne bottles
6. Dust and other fine particles

Improved optical sorters used internationally can identify smaller fragments. This infrastructure could deliver marginal improvement in processing loss, however, are not the silver bullet for contamination at a system level.

Prioritisation of collected glass

The best option is for collected glass is to be returned to the furnace for bottle-to-bottle recycling, thus maximising the circularity of the material. Currently in New Zealand there is an oversupply of glass to the market and the furnace is near capacity for collected bottle cullet. Large amounts of collected glass goes into other applications, including roading aggregate, landfill cover, fine grind applications and other Council applications. An increase in collection rates would further require use of other end markets if furnace capacity was not increased.

The first consideration is that the best glass gets back to the furnace, optimising the highest quality glass within the closest radii to achieve the lowest carbon footprint. This then leaves a portion of glass - mainly located in the South Island - which cannot be recycled onshore. There are several options for this glass which vary in cost, emissions, and ease. We have considered these options with the primary goal of increasing the circularity of glass as a material and minimising waste and "down-cycling". Some of the uses are likely to have benefits for other industrial sectors that we note here, however further work is required to calculate the total benefit to New Zealand.

Glass wool to increase the energy efficiency of New Zealand's built environment

Glass wool is a material made onshore in NZ from recycled glass, providing an opportunity for excess glass to be utilised by shifting it into a different circular process.

Glass wool can itself be recycled[46], thus maintaining the circular property of glass as a material. Currently in New Zealand the post-consumer glass wool is mostly ending up in landfill[47], due to the presence of organic material in the binder. However, the nature of glass allows for a technically elegant solution to remove the binder and leave the remaining glass, simply using high temperatures to vaporise the organics, leaving the glass fibres.

Current production utilises approximately 80% recycled glass. The chemistry of the glass is a factor, with bottle glass and flat glass being of slightly different chemical makeup. Currently the Tasman operation produces glass wool from flat glass, while the bottle furnace takes the remaining flat glass plus bottle glass. The flat glass is offcuts from imports (NZ produces no flat glass). Using bottle glass for insulation is possible but the limitation, once the chemistry is accounted for, is contamination. The glass fibres are produced by electrically melting the glass, then ejecting it through very small holes in a "spinner". Any contamination blocks the small holes.

Like the furnace, there is a single operation[48] in NZ producing glass wool, and it is currently at capacity, which is an issue for New Zealand as building for climate change is increasing the demand for insulation.

The glass would likely have to go through a beneficiation process in Auckland, but the manufacture of glass wool occurs near the existing beneficiation facility so extra transportation of glass will be minimised.

Sweden has a high collection rate for glass and has therefore had to look at alternative uses for collected glass. Roughly 30% of Sweden's collected bottle glass cullet goes into glass wool manufacturing.

Export of flint glass for flat glass remanufacture

Another option is to export flint glass to be recycled into flat glass. This option has negative carbon effects as it cannot be done onshore leading to a high carbon cost associated with the transportation offshore.

Export of excess glass to an Australian manufacturing facility

Another option is shipping the excess glass to an Australian manufacturing facility where there is demand for used container glass to go into their furnaces. This maintains the circularity of the material but does include a large carbon cost associated with the transportation. Suitable export options exist in South Australia/Adelaide, Brisbane, Sydney and potentially other locations.

Downcycling of glass and replacement of other scarce materials

"Downcycling" is to be avoided as much as possible, but in designing a realistic model for glass collection and recycling, we realise that the logistics of glass consumption in New Zealand mean that circular options are not possible for all glass entering the market. Therefore, downcycling options should seek to minimise emissions and have maximum

46 Fletcher Building, personal communication

47 In terms of waste minimisation, 50% of NZ's waste to landfill is from construction and demolition. Our current building methods restrict the utilisation of materials such as wood and insulation, due to the widespread use of adhesives to construct

48 There used to be two, but the South Island one was mothballed after the Christchurch Earthquake

positive impact on New Zealand. An option that is currently in use primarily in the lower regions of the South Island is turning glass cullet into aggregate for roading. This has the benefit of reduced emissions from not extracting and transporting raw materials (sand), as well as providing infrastructure for New Zealand.

The lowest rung – and leaving the technical cycle with no other benefit

On the lowest rung of the waste hierarchy is sending glass to landfill.

Table XII End market hierarchy based on waste hierarchy, Grant Thornton analysis

Summary table of prioritisation of end markets

#	End markets	Waste hierarchy level
1	Bottle-to-bottle recycling in New Zealand	Circular recycling
2*	Bottle-to-bottle recycling in Australia	Alternative circular application
3**	Glass wool	Alternative net positive application
4	Roading aggregate	Alternative net positive application
5	Glass to landfill (to be avoided)	Waste

*This option is often not financially viable (as is currently the case) based on shipping prices across the Tasman. No other circular applications were identified in New Zealand (of any scale).

**Potential for glass wool to be circular is promising, increasing favourability of this option in terms of the waste hierarchy. The positive end-outcome of warmer, healthier, more energy efficient homes increases favourability of this option and could be given greater weighting.

Scheme Outcome: Increasing bottle to bottle recycling

Initiatives which target increased glass collection deliver increased cullet and *potential* for value and recycling outcomes from it. Expanding end market capacity allows for realisation of increased bottle-to-bottle recycling, which would otherwise be constrained.

Large losses can occur from collections, logistics, and processing, and can materially decrease remaining volume available for bottle-to-bottle recycling outcomes. Initiatives increasing quality of collections decreases losses across the collection and processing network and consequently, increases the outcomes from collected glass.

The maximum bottle-to-bottle recycling level is:

$$Min(Glass\ collection\ , Furnace\ and\ processing\ capacity, End\ market\ demand) - losses$$

Equation A: The maximum bottle to bottle recycle rate

Increasing collections, alongside addressing capacity constraints in end markets, and reducing losses will result in the greatest volume that can recycled bottle-to-bottle.

End market demand should be similarly supported by making available high-quality glass cullet and bottlers demanding high-cullet bottles from the bottle manufacturer.

Section Summary

Summary of proposed scheme targets and staged levels of the waste hierarchy

In the section above we have described how a number of initiatives can collectively reach an overall target. Table XIII below summarises the proposed targets if all initiatives are implemented.

Table XIII Summary table of scheme targets

Target	Baseline	Year One	Year Three	Year Five
Reduce single use bottles to market	0%	-6.5%	-12.5%	-15%
Increase collection rate	75%	80%	85%	90%
Increase percentage of glass cullet in new local bottles	69%	72%	85%	90%
Bottle-to-bottle recycling rate	62%	75%	81%	87%
Reduce glass litter	-	Contestable fund of $350k p.a. to fund reduction and collection initiatives		

Overall summary

An optimised scheme for Aotearoa New Zealand will:

- Reduce single-use containers through encouraging low packaging alternatives and refillables
- Increase the collection rate
- Increase the % use of cullet in remanufacture
- Reduce contamination and increase quality
- Prioritise glass into its highest use when downcycling at end of life

As a result, bottle to bottle rate will be significantly improved.

Network Design

Introduction

The current collection network suffers from a lack of coordination plus high collection and logistics costs. Collection and logistics to end markets is a significant financial burden on Councils with their remit limited to their region. Lessons from collaboration between Councils in proximate regions and aggregation points, such as the Christchurch Hub, shows a coordinated approach can deliver efficiencies, and additional improvements and efficiencies are possible at a national level.

A network design was created to enable the desired outcomes from the scheme design:

- Maximise quality collections
- Minimise contamination
- Establish efficient return collection logistics
- Leverage existing infrastructure, such as logistics networks and existing transfer stations with bunkers
- Build capacity into the network

Three high-level network options were considered:

1. National Kerbside network for glass
2. Reverse vending machines (as proposed by CRS design)
3. Community collection bins at high frequency

To consider the three options for network design and consider ability to achieve the design objectives, we needed to accurately model the physical system, system constraints and the associated cost of each part of the system.

Outcomes that can be achieved through any scheme are influenced by both inputs and outputs into the system, infrastructure limitations and end markets. In New Zealand this is especially relevant with our isolation from other markets and limited infrastructure. Currently bottle-to-bottle recycling is not as high as it could be, based on collected volume. An approach not considering inputs and outputs into the system, or holding these aspects constant, will not deliver the full outcomes and environmental benefit possible.

These elements were all front of mind and led to our decision to model the entire system, from glass to market, to end market capacity and prioritised application.

To assist with decisions and optimisations we created a digital twin of national glass consumption and the three collection network options.

Our system-modelling approach allowed the following:

- Comparison between network options
- Impact of different scheme targets and levels at different years
- Comparison of network configurations to refine design
- Add capacity constraints at key parts of the system
- Estimation of the benefit to society based on scheme targets and network costs
- Emissions profile between options
- Comparison of emissions between network configurations to refine design
- Managing agency costs to deliver the scheme
- The appropriate levy to cover managing agency costs.

It allowed us to optimise at a national systems level for cost and emissions generated considering the very real constraints in key infrastructure.

Our system design held glass consumption at the centre. Every household and every bottle – tracked through every leg.

A digital twin of the system allowed the impact of any system change to be modelled and optimised, in volume, cost and emissions.

National Network Design Approach

In the existing patchwork of collections, collaborations improve recovery rate

Glass recovery in New Zealand is currently under the purview of individual Councils, rather than a national network. From the Councils we interviewed, we observed that each adopts its own methods for the collection of glass from consumers and has its own approach to collected glass.

New Zealand's geography presents an additional challenge in creating a comprehensive glass recovery network. The population is spread geographically, and the glass manufacturing facility is based in Auckland, making the transport of recovered glass both costly and carbon intensive. Some Councils did not have sufficient scale or infrastructure to send glass to end markets cost-effectively.

We observed voluntary collaboration between Councils in some proximate regions. While these were exceptions rather than the rule, they tended to lead to better outcomes, particularly in volumes of bottle-to-bottle recycling and cost.

It was clear to us that collaboration across the country presented a good opportunity to design an effective national recovery network that would save cost to society and deliver larger quantities and higher quality glass cullet to furnace.

Hub and Spoke model leveraging existing infrastructure

Designing the model configuration required an understanding of the consumption of glass across all of New Zealand, establishing the network required in each region, then seeking to utilise existing infrastructure in these regions.

The aggregation at the Christchurch Hub delivers the following benefits:

- Aggregation of volume collected at smaller regions at a major logistics centre, with access to rail and coastal shipping freight
- Quality monitoring – an experienced team trained in quality monitoring, ensuring high quality glass going from the facility can be beneficiated at low cost
- Added network storage capacity – allowing for smoothing of highly seasonal collections over summer months and a smooth flow of glass to the furnace.

Taking lessons from collaborative success stories like the Christchurch Hub, we developed a **"Hub and Spoke" model** to replicate the success in that region.

This network enables an even flow (rather than a seasonal one) of glass to the beneficiation plant in Auckland across the year and creates sufficient capacity to maximise the capture of collected glass.

Current examples of 'Spokes' are the aggregation of collections of smaller Councils. This works well in some regions, however, in general is too influenced by the borders of each Council and their responsibility for collecting in their regions. They are not necessarily the most efficient locations for aggregation, and so we have taken a bottom-up approach to defining Spokes. These Spokes are existing transfer stations that are located optimally to aggregate kerbside and/or rural community collections and deliver storage capacity required for the region.

Spokes aggregate volume from the collection network. The collections network collects glass from every household throughout the country, either through the urban Kerbside collection network or the Rural community collections network.

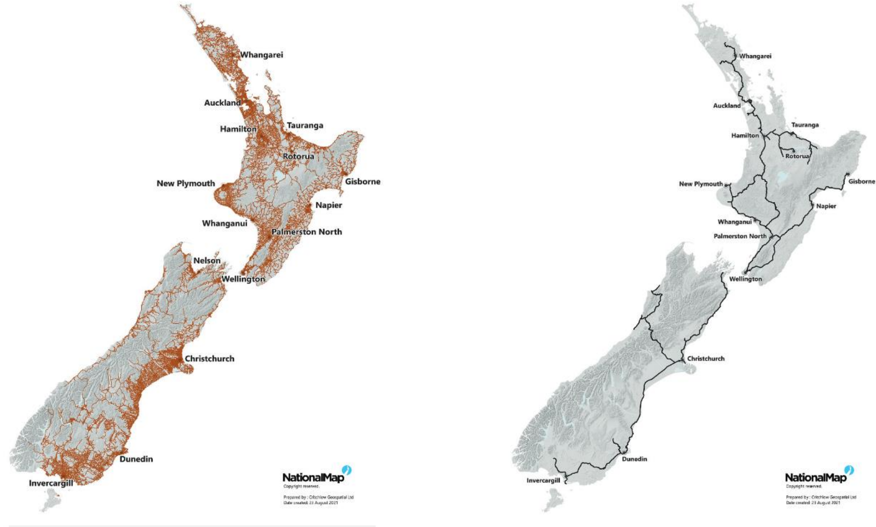


Figure 19 New Zealand Road (left) and Rail (right) Networks

Hub locations

Along with utilisation of existing infrastructure, a key factor in the selection of Hubs was the proximity to transport networks that deliver an optimal mix of cost and carbon intensity.

There are three ways that glass cullet can be transported long-haul back to the beneficiation plant in Auckland; by road, rail, and coastal shipping. Insufficient planning or poor Hub placements would restrict long-haul options to road, the most flexible but carbon intensive option.

Coastal shipping becomes more cost-effective as the long-haul return distance increases. It is the cheapest option for Southern Hubs but is only possible from certain centres.

Rail has the lowest emissions of the three options but is restricted to the rail network infrastructure as shown above. While road has the advantage of accessibility and avoids double handling of cargo, it is also the most expensive over longer distances.

Roading is favoured for in-region network legs and for shorter return distances.

Our analysis found that total aggregated volume of consumed glass (particularly influenced by population) was not the only important determination for Hub count and placement. Glass is a heavy material to move around the country, so double-backing and long road journeys to aggregation points were minimised.

Several of the proposed Hubs are in smaller regional centres, these fill the aggregation need in these less populated and geographically isolated areas. Regional Hubs allow volume from that region to get onto long-haul infrastructure, especially the rail network, at the earliest possibility – reducing emissions and network cost.

As a result, we selected 11 Hubs (Including Auckland) in locations that made optimal use of the rail and coastal shipping networks shown in Figure 20.

Additional details on this selection are in the Modelling approach section. Many other configurations including a smaller number of Hubs (3, 4, 7, 9, 10 and 12) were modelled. Each additional hub of the final 11 Hubs addressed the geographical challenges stated above and reduced overall network cost and emissions.

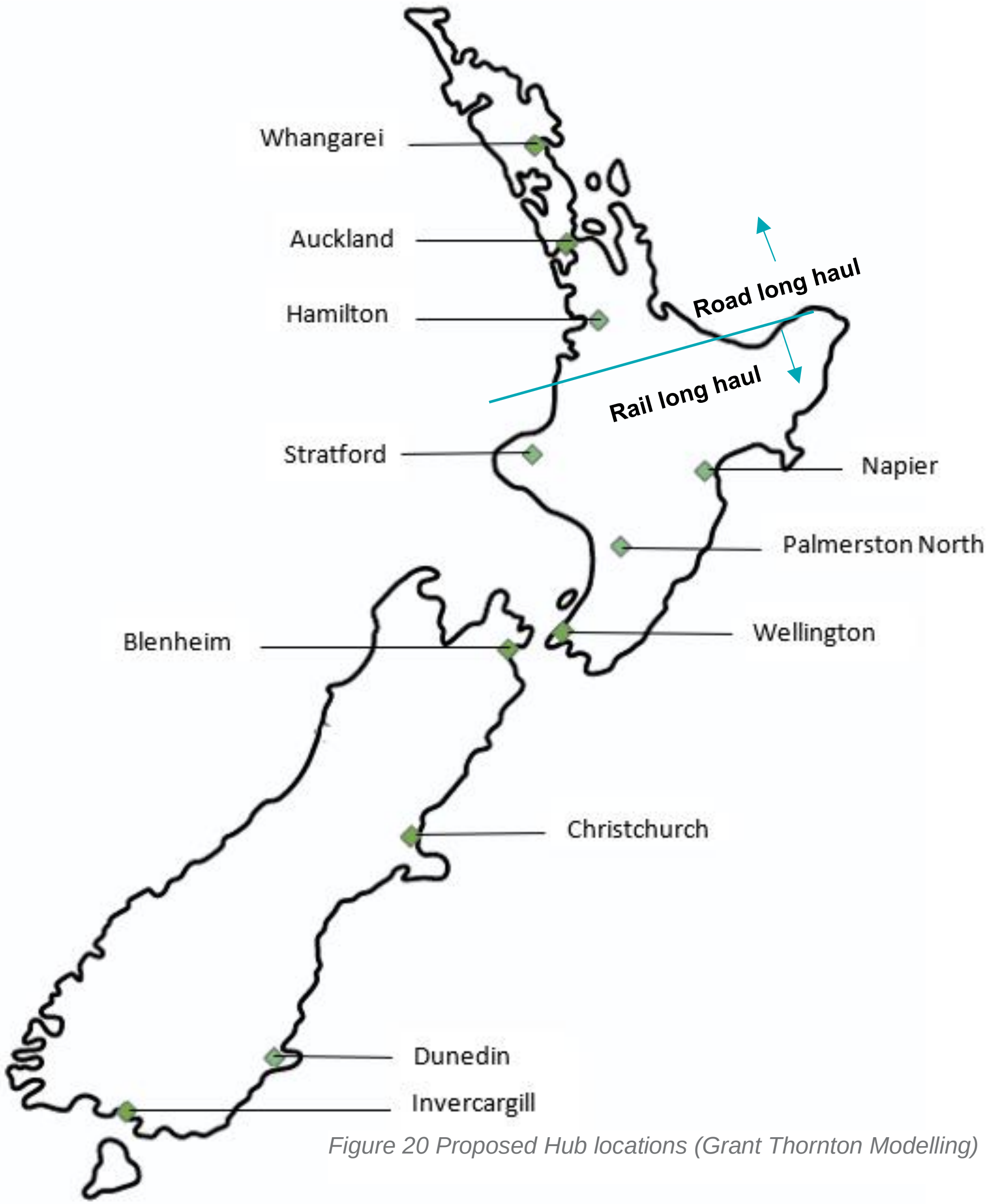


Figure 20 Proposed Hub locations (Grant Thornton Modelling)

Spoke locations

Spoke locations are a key point of aggregation, minimising the distance of truck journeys to Hubs and creating capacity in the network to smooth glass flows across the year. Collected container glass is transported from Spokes to Hubs via open-top trucks with an average capacity of 20 tonnes. Spoke locations were considered based on merits according to the following factors:

- Volume that would be aggregated there, especially influenced by population
- Distance to spokes at the household level
- The need for aggregation of rural collections
- The Hub that a spoke would be aggregated to.

Spokes were shortlisted based on an initial list of the existing transfer stations across the country, more than 120 in total. This was important to maximise use of existing infrastructure, such as bunkers, loaders, and staff. Other theoretical locations could have better geographic locations however, the investment in infrastructure and sole operation of these sites make them not financially viable for use for a single scheme.

Through analysis of the current state of glass recycling, along with insights from initial models, the list of Spokes was reduced to create a more streamlined material transportation network and reduce infrastructure complexity and cost. Multiple iterations were used to determine the optimum combination of Spokes. Some spokes specifically address large volumes in urban areas. Other Spokes address aggregation requirements of rural regions with community collections.

Optimising the list for utility has resulted in our recommended configuration of 82 Spokes (Figure 21).

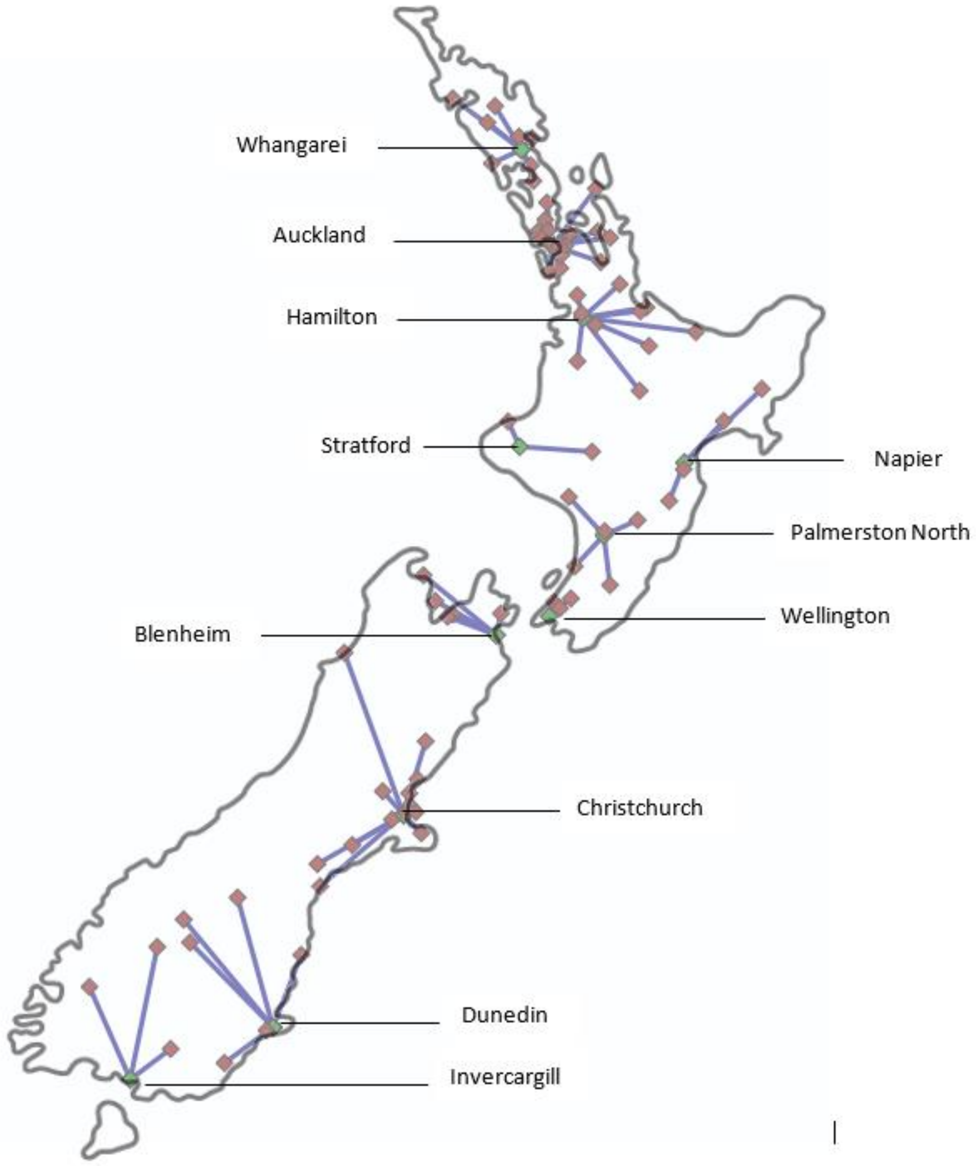


Figure 21 Proposed Hub and Spoke network (Grant Thornton)

Designing the collection

Underneath the network design is the collection method to be used. Three collection methods were considered:

1. National Kerbside collection for glass
2. Reverse vending machines (as proposed by CRS design)
3. Community collection bins at high frequency.

Each collection method has its own cost and emissions structure, and these were modelled separately to contrast and evaluate the best option for New Zealand.

The consumption of container glass in New Zealand takes place in three main areas: households (both urban and rural), hospitality venues and public spaces. Network considerations have been made for each area, and the most effective collection method for each.

Household

The large majority of consumption takes place at households. Current collection is mainly done at kerbside in urban areas, with rural areas having drop off locations or community bins. There is no national standard for kerbside collection and some councils opt to comingle glass with other recyclable items, including metropolitan regions of Auckland and Christchurch. This means that only 49% of the population receives a glass kerbside collection.

Rural and urban collection networks

The network design allocates each household to either an urban kerbside collection network or the rural community collection network. Rural settlements and small urban areas are areas of low population numbers, and often densities. Small population bases and population spread of larger distances make a kerbside network, impractical and not cost-effective. Practicalities of delivering kerbside to that area as part of a national scheme was also considered when deciding whether a town would be a good candidate for kerbside collections or not. A simple split of 'Rural' and 'Urban' households was quickly dismissed as being too rough to be close to a practical split for these networks.

Discussions with the collections industry and Councils revealed that a single collection truck would likely be able to service 5,000 households. This practically means that any town of less than 5,000 households would need to be serviced from a nearby town.

Our initial starting point for the split was LINZ area type designations. Each household was geospatially mapped into a LINZ town or rural region. All designations of Medium urban areas or larger, were automatically included in the kerbside network. Small urban areas were then considered for inclusion into the kerbside network based on the following characteristics and tests:

- Population size – all towns larger than 2,300 households were included, and towns nearer this threshold were considered based on the other factors below
- Population density – some smaller towns with higher density were included. Higher density towns were often satellite towns, proximate to bigger towns
- Proximity to larger urban area – small satellite towns to larger towns with a kerbside network are much easier to service, therefore a number of these satellite towns were added into the kerbside network, to be serviced by the nearby town

The largest town missing out on the defined kerbside network (being serviced by the community collections network) was Te Anau. This was primarily due to its isolation. It would be expensive to service this area with a kerbside model, and the town wasn't large enough to be serviced by one truck full-time. A 2hr drive each way from Queenstown would likely be required.

Urban collection through kerbside collection

The main method of household collection is through kerbside collection, where a collection truck visits each household to pick up a crate of purely glass, and colour-separating into the truck.

Kerbside recycling delivers the most convenience to the consumer, as well as being the current method of recycling. These two factors should not be understated as New Zealanders put a high price on convenience. A recent survey found that 50% of consumers would not walk more than 20 meters to find a recycling bin and that 73% preferred kerbside collections to community bins or a deposit-based scheme[49].

[49] Horizon research, Packaging Survey, March 2022

We believe a kerbside collection method has the potential for higher capture rates than, that achieved by either alternative, where the consumer has to leave their home to return their used glass.

Rural areas (Community collection points)

While colour sorting at kerbside is the widely accepted best-practice method for collecting the most material with the least contamination, New Zealand's widely spread population means that it is not feasible to service every household at kerbside (or farm gate as the case may be). A total 13-16% of kiwis live in rural areas[50]. The solutions currently in place in many rural communities are either community recycling centres (both manned and unmanned) or drop off community bins.

These drop off points are at central locations making drop offs as easy as possible for the rural community (Figure 22).

The largest rural networks consist of unmanned drop off points, these are the best option for wide coverage of rural communities where kerbside service is simply infeasible and in aeras too small for a manned service centre or aggregation point. When kerbside collection is not feasible, an alternative of community collection points was modelled.

These collection points were designed to be large colour-divided skips with lids and signage. This allows for a lease model of the bins and servicing in every region by local operators able to swap out full skips for empty ones and return full skips to Spokes.

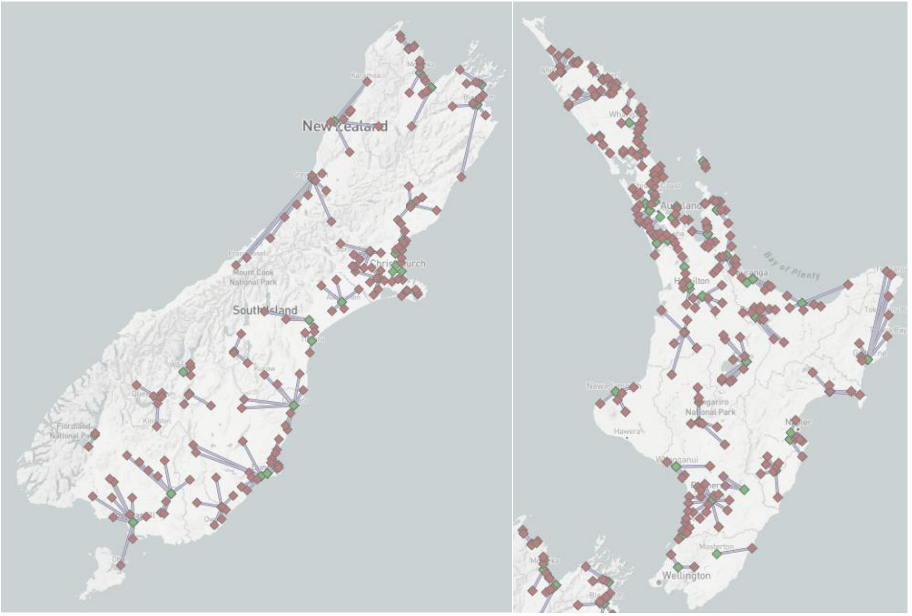


Figure 22 Rural Hub and Spoke network modelling (Grant Thornton)

Hospitality

Hospitality provides the greatest opportunity to increase the glass capture rate. The current level of 10-15% of glass consumption at the hospitality level is mainly being sent to landfill, with individual hospitality venues and waste management providers opting for the more convenient and cost-effective option.

Through incentives in the scheme design, Hospitality venues will be responsible for the recovery of the glass they consume. The network is designed such that the glass consumed in hospitality venues is recovered through private collection and subsequently aggregated at Spoke level. The cost of collection is thereby put on the venue, and the cost of transport to the glass manufacturing facility in Auckland is on the network. Through the various scheme incentives, most notably the reduction in single use bottles, this volume is predicted to reduce the overall cost of the recovery network.

[50] Ehinz, indicators urban-rural profile (16.3%); Trading Economics.com, rural population percent of total population (13%)

Scheme infrastructure

There is significant recycling infrastructure already in the network aligned to collection and recycling glass through a kerbside network. Most of this infrastructure is owned by Councils in the form of glass bins, bunkers, and other transfer station infrastructure.

Since 2018/19 the GPF has funded $900k of glass recycling infrastructure and more infrastructure has been funded directly by Councils.

There is only a single beneficiation plant and single container manufacturing facility nationally and this poses a logistical challenge to get collected material back to a single place. However, our capacity modelling shows that there is sufficient capacity if the scheme, producers, and the bottle manufacturer can collaborate to increase the cullet capacity in the furnace.

This scheme was designed to leverage existing infrastructure, and support improvements to infrastructure that will create capacity to deliver a greater quantity and quality cullet through the network.

Leveraging existing infrastructure will allow improvements in recycling outcomes much quicker and for a lower cost.

Internationally, CRS schemes are more likely to own substantial processing infrastructure than product stewardship schemes focused on a defined product material.

While investment in improved infrastructure will be required as part of this scheme, this can be in the form of additional investment to increase capacity and improve existing infrastructure – a complete overhaul is not required.

We have planned key elements of this network (Hubs and Spokes) at existing Transfer stations (mostly Council-owned), to leverage the existing infrastructure at these facilities.

Infrastructure investment will go towards:

- Improving and expanding bunkers in the aggregation network
- Investment in collection bins that will support collection of high-quality glass

Transfer stations and bunkers

New Zealand has a large network of over 120 transfer stations nationwide. Many of these undertake collection, aggregation, or processing of glass currently. Existing transfer stations are well positioned to undertake aggregation of glass. Many are also well positioned to store glass (in bunkers) with large concrete aprons, existing bays and other transfer station machinery and staffing.

Bunker infrastructure

We have estimated an average cost of $120k - $140k of increasing infrastructure based on GPF funding grants for bunkers. Recent investments in bunkers have varied significantly between sites, however, based on existing infrastructure, distance from supply of concrete and capacity required. Increasing capacity of a concrete pad through additional inter-locking blocks, for example, could be completed for $50k - $60k.

If a larger capacity uplift were required at a larger Hub, this infrastructure cost could exceed $500k. Limited bunker capacity in the Wellington region could require this level of investment at an appropriate site.

Overall, we have estimated a one-off $2 million budget for infrastructure investment in bunkers to build sufficient capacity across the network.

In addition to this, we have estimated a budget of $175k to invest in equipment to handle glass at the hubs, with a refresh of this equipment occurring every 10 years.

Additional work would be required to understand current condition, capacities, and infrastructure investment requirement at each specific aggregation site.

Rural collection points (or Community collection points)

Rural collection points could be established with scheme-owned bins. Outlay for these could range between $12,000 and $24,000[51] for a robust steel bin with sections for different colours.

This would be a significant outlay and asset base for the scheme and therefore we have modelled this as a lease cost. This lease cost is an even more significant cost in the

[51] GPF scheme manager, insight on recent examples

community collection model, making this option comparable in cost to the kerbside collection despite removing the requirement of kerbside collection trucks.

If additional capital investment or debt were available, an ownership model for these could be more cost-effective.

Bins

The current kerbside network can be divided into three groups, each requiring a different approach to balance outcomes, effort in transition and cost:

1. Fit for purpose to support collection of high-quality glass - **leverage**
2. Glass separate bins, but not optimal for collecting high-quality glass – **improve over time**
3. No glass separate bins - **invest**

Many regions already have fit for purpose glass collection bins, these would be leveraged in this scheme to minimise waste and support a fast and smooth transition. In these regions the scheme could work with Councils to take on the service management, novating the collection contracts and acquiring the bins in exchange for ongoing operation of the service.

Regions with glass separate bins that do not colour-sort tend to have bins optimised for collection cost, rather than quality of collection. These groups are typically larger bins, with lids, that are mechanically lifted into a truck. The scheme could work with these Councils, novate the existing contracts and transitioned to a fit for purpose glass collection bins at the end of the existing contract. This would be a crate, or open-top bin of no greater than 45L, enabling lifting and colour sorting at kerbside to occur. We have forecast $0.5 million per year for capital expenditure between ongoing bin renewals and bunker improvements, covered by the levy.

Regions without glass-separate bins would be a priority for investment and these regions would be the first regions with the bins that will eventually be nationwide. We have estimated 500,000 households would require new glass collection bins at the start of the scheme[52] and forecast a one-off cost of $10.9 million to establish these[53].

Other infrastructure

Establishing a national recycling (or CRS) scheme from scratch would require significantly more infrastructure, including beneficiation, aggregation and bunker infrastructure, logistics and fleet and crushing machines.

This scheme has been designed to leverage existing infrastructure, this delivers the most cost-effective scheme and avoids the unsustainable outcome of stranded assets. This is consistent with the expected product stewardship scheme effect of collaboration, specifically:

d. i) Optimal use of existing and new collection and processing infrastructure and networks, and co-design and integration between product groups.

Financing one-off infrastructure

The one-off infrastructure investment in the kerbside network design is relatively small for a national scheme and when compared with alternatives, such as the CRS.

However, initial infrastructure investment would be required along with financial support.

Due to the one-off nature of the infrastructure investment, we have not built this into the levy as we considered a levy that was covering ongoing costs of the scheme to be more appropriate. Producers in regions where schemes regularly update levies have difficulty planning and pricing accordingly, so this one-off increase was avoided.

[52] Based on count of the households in the Auckland region

[53] $10 per bin estimated based on market costs of 45L bins readily available

Financing options

One-off infrastructure costs to establish the scheme could be funded in one of the following ways:

1. **Member loans** – Member loans have been a successful form of infrastructure financing for other schemes internationally, notably the recent CRS’ in Western Australia and Queensland.
2. **Other Debt** – Alternative debt financing could be sought from a government agency, or private institution. This has also been a financing mechanism used by Australian container return schemes.
3. **Waste minimisation fund** – The entity could apply for a waste minimisation fund loan or grant as other product schemes have been successful in doing.

Modelling Approach

Overview of quantitative method

We modelled the entire system, from glass to market, to end market capacity and prioritised end market of glass cullet. To assist with decisions and optimisations we created a digital twin of national glass consumption and the three collection network options using the Alteryx modelling tool.

The modelling required necessitated managing a high degree of uncertainty. Single-point estimates would be an inaccurate simplification of the relative uncertainty. Similarly, compounding simple ranges in assumptions deliver little insight into the likely cost and risk.

We undertook a stochastic approach to assumptions for which there is uncertainty. This involves gathering three-point estimates (Low, Most-likely, High) capturing the full range of possible values. Our cost modelling produced distributions/ranges of possible outputs, encompassing all possible eventual outcomes.

This allowed results to be compared along both the lines of likely cost (probability-weighted) and risk (what is the chance it is significantly more?).

A stochastic model was used in this modelling exercise, as it allowed for a degree of detail on a national recycling network that has not previously been achieved. From this detail, a reliable costing model accounting for variance in prices and rates often associated with logistics has been modelled.

Our pricing distributions have been combined in a Monte Carlo simulation using thousands of possible scenarios to give a distribution of total cost range of the network.

Alongside costing the model, every part of the network has the carbon footprint measured such that each model and scenario can be compared to determine where improvements can be made, and which collection method/scenario is optimal (Figure 23).

See the following sections on Cost Model and GHG Emissions Comparison.

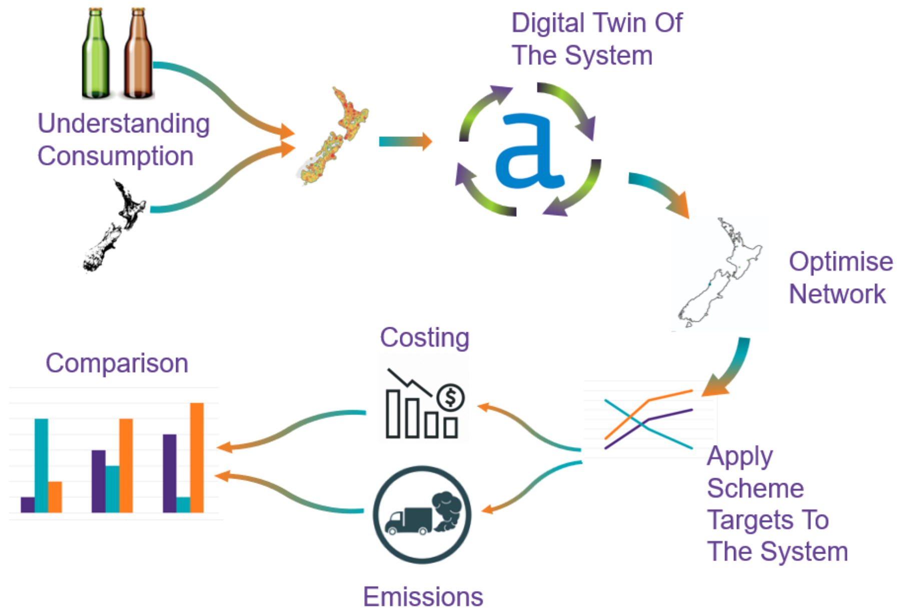


Figure 23 Depiction of modelling undertaken

Glass Consumption

The first step in the modelling process was to gain an understanding of where glass is consumed around New Zealand. This is an important consideration due to the difficulties with the geospatial spread of the population of New Zealand.

Council collection data was scaled up to get to the glass to market value and then used to get a distribution of glass in each region. Population and household data was used to allocate glass consumption to the household level. An average glass consumption per person was used based on glass to market from the GPF accreditation report.

An average household consumption was created from the average of these two numbers, along with a dataset containing geospatial information on every household in New Zealand as shown in LINZ records[54].

Geospatial modelling was used to allocate households to their Council district or region and match the appropriate average consumption (Figure 24). The total tonnage distributed amongst households (consistent with regional consumption) was consistent with the GPF accreditation report figure of glass to market: 258,748 tonnes.

Volume aggregation

After determining where glass is consumed in New Zealand, the next consideration is how it gets back to the furnace to be turned into new bottles. The Hub and Spoke network as explained earlier was developed and optimised to make use of existing infrastructure and transport routes. The aggregation into larger volumes facilitates more efficient long-haul legs by 20-foot container.

Our consultation with industry underlined the reality that transport from defined points with a limited or pre-determined method of transport is often quite fixed. Therefore, in modelling the Hub to beneficiation plant leg, we used whatever the predominant transport type for that journey is and costed it appropriately. For example, glass aggregated at the Hub in Wellington will be sent by train, whereas glass collected in Northland will be sent by road.

The image below is a visualisation of national glass consumption, based on glass collection data applied to population and household – a first of its kind analysis

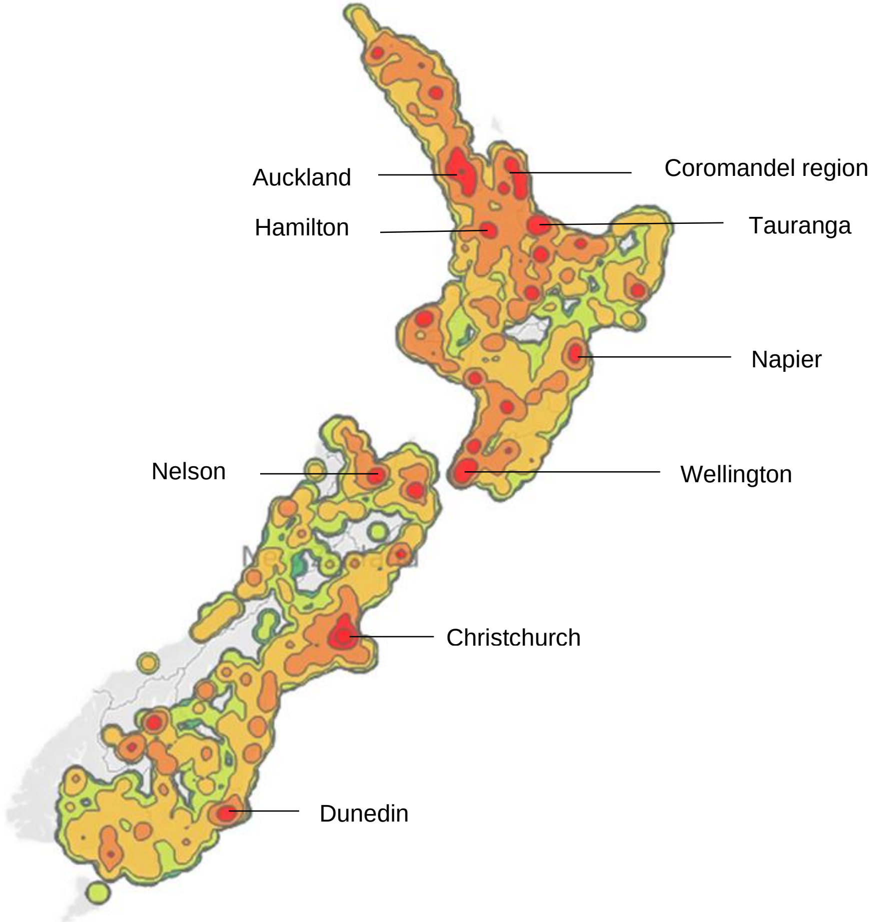


Figure 24 Heat map of glass consumption in New Zealand (Grant Thornton)

54 https://data.linz.govt.nz/layer/50804-nz-property-titles/data/

Capacity of the furnace

There is an oversupply of glass to market. The current glass to market figure in NZ is 258,748 tonnes of glass[55] and the furnace only has the capacity to process approximately 150,000 tonnes based on current levels of cullet in the average recipe.

Since not all collected glass can be recycled bottle-to-bottle, a key consideration initially is getting the best glass back to furnace. In our designed network, best glass is defined by prioritising glass which has the lowest cost to get back to the furnace. All other glass is aggregated at the Spoke/Hub level to be used in alternative applications. All glass that makes it into an end market has a value associated with it, but the value varies significantly depending on the value of the end market.

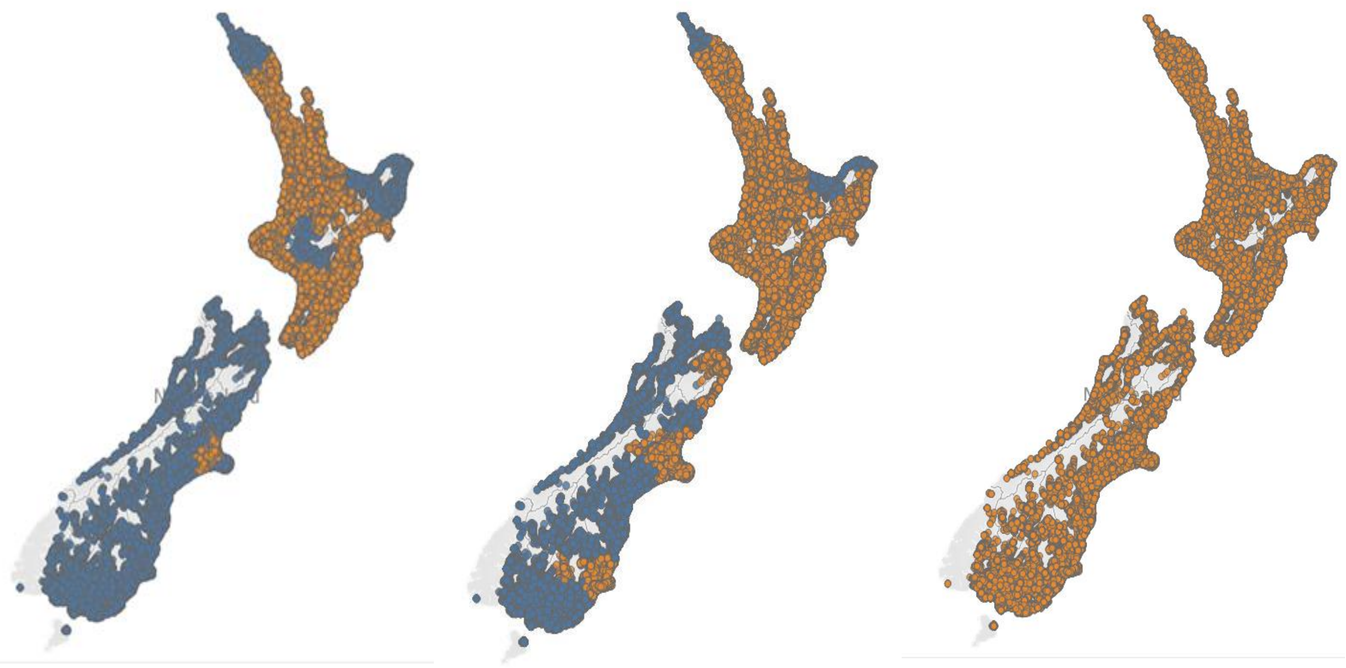
For glass sold to the local glass container manufacturer we have estimated a price of $90/tonne[56] with a +/- of 15% to create a three-point estimate. In practice, the higher quality the collected glass is, the higher value it will be to the manufacturer. A higher price could be agreed with the furnace if higher quality is delivered. Higher levels of glass cullet would also bring the cost of local production down due to lower raw materials and energy required. This could reduce the cost of bottles to market, offsetting some of the price impact of the levy introduced.

Any glass that is surplus to the capacity of the beneficiation plant is applied to local applications, as is common currently.

The left chart in Figure 25 shows the most cost-effective volume to get back to the furnace (orange) for bottle-to-bottle recycling.

By Year 3, all collected volume could be recycled bottle-to-bottle by the furnace because of initiatives to increase furnace capacity and reduce single use glass to market.

Capacity constraint modelled on the furnace, lowest cost volume recommended to be prioritised for bottle-to-bottle



Baseline year, lowest cost volume to get to furnace

Year 1 of the scheme, more volume can be recycled bottle-to-bottle

Year 3 onwards, all volume collected can be recycled bottle-to-bottle

Figure 25 Progression of volume able to be returned to the furnace for bottle-to-bottle recycling (Grant Thornton)

[55] 2022 GPF accreditation report

[56] Derived by Grant Thornton, informed by our industry interviews, of what a reasonable value for high quality cullet is worth in the market today. Mixed glass, or contaminated glass would not yield nearly as favourable a price

At the Spoke level, the following Spokes (shown in Orange) are the lowest cost volume to fill initial furnace capacity and should be prioritised for this to minimise the cost of the network (Figure 26).

Spokes shown in blue are higher-cost to return to the furnace, and are therefore candidates for alternative use, such as in-region roading application or export.

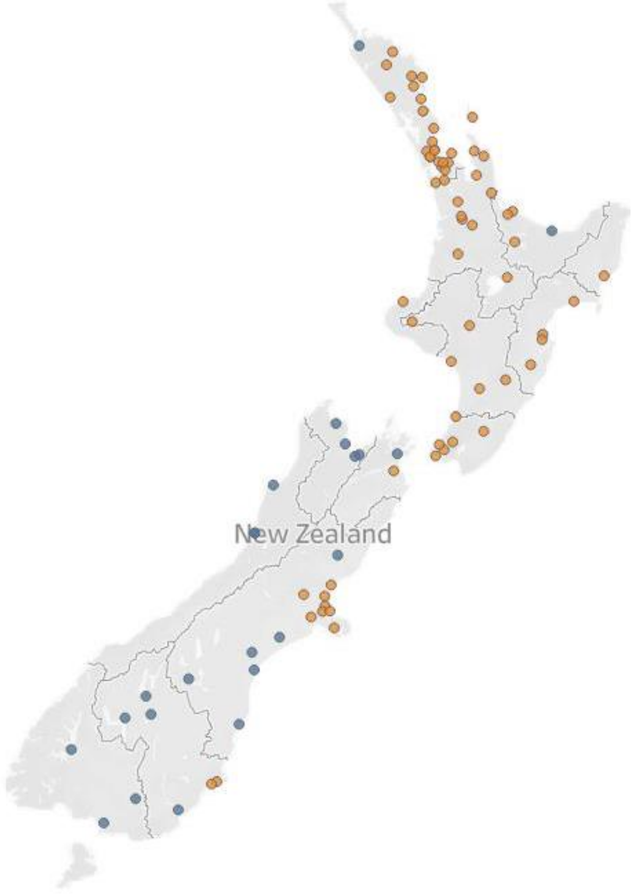


Figure 26 Initial priority for return to the furnace given to lower cost volume to return (orange)

Collection Network

Once a Hub and Spoke model was configured and optimised, the next step was to create a collection network to supply the Spokes with volumes of glass.

Each of the three collection networks are modelled in separate digital twins, and modelled against the scheme targets at years 1, 3 and 5 (steady state).

1. National Kerbside Model

To model the kerbside collection, each household was identified within the kerbside-serviced areas – each with its associated glass consumption to be picked up. This level of granularity has not been modelled before at a national level. Collections were modelled based on current collections undertaken, no additional efficiencies or truck types were assumed to reduce optimism bias common in this type of modelling. Key factors considered were to match the type of collection and frequency of service. Also relevant at a regional level is household density and this influences the eventual cost in each region.

Our analysis included discussions with Councils and waste management companies who undertake kerbside collections of the standard and frequency desired for the network. This input was used to determine three-point estimates for costing kerbside collections at the household level.

The next degree of granularity of modelling for collection routes would be route mapping. This analysis should be undertaken as part of a clean-sheet model prior to procurement however, the additional degree of accuracy was not required at this time.

The emissions of collection are also done on a per household value which is calculated from values given by industry. We have used assumptions consistent with the average current collection fleet used in New Zealand for this activity. A large opportunity exists to transition this fleet to zero carbon alternatives, this is discussed later. The cost of collection and transportation are then aggregated to give a total cost of collection over each leg of the network. All costs have a three-point estimate to ensure the model takes into account variability in pricing.

Community collection points

When kerbside collection is not feasible, an alternative of community collection points was modelled. These collection points are based off one bin per 500 people for each rural area. Each household then returns their glass to the nearest collection point, which is then aggregated at the nearest Spoke, to join with the rest of the volume being collected from kerbside. The network is shown below with Spokes in green and community collection bins in red (Figure 27).

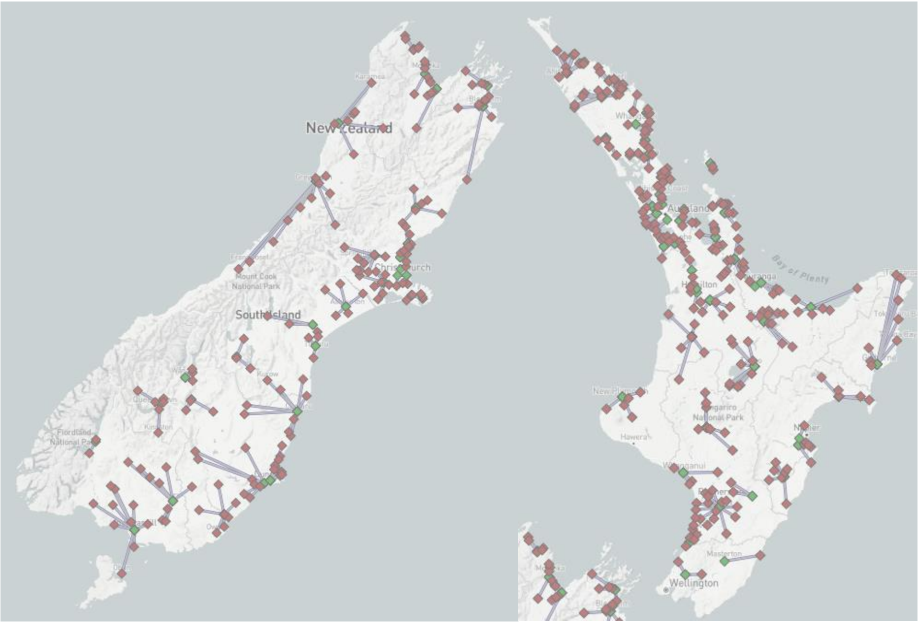


Figure 27 Rural Collection Network

2. Container Return Scheme via RVMs

The container return scheme design incentivises people to recycle by placing a value on the container. It also removes the glass from the kerbside system in favour of drop off points located at supermarkets and Zero Waste Network locations.

We have modelled the cost of the CRS network in two ways, both helpful for different comparisons. **The first comparison is the CRS costing**, as outlined in the consultation documentation. This gives a good comparison of the overall total cost forecast, against the alternatives modelled, which have different components modelled at a much more granular level.

The second CRS costing is a bottom-up remodelling of a CRS collection network as a digital twin of the system. This used assumptions consistent with the CRS Cost Benefit Analysis[57] and applied these to the real collection volumes and aggregation network in our digital twin. This option gave us a like-for-like comparison of the RVM collection method to kerbside and community collections network models.

The re-modelled CRS started by identifying locations of the 741 supermarket locations, as well as the 51 Zero Waste Network locations.

Volumes from households were geospatially modelled to aggregate at the nearest location to determine the collection at each site. Participation cost was modelled consistent with PwC's estimates[58] of the cost of time for participation.

Emissions from driving to the drop off locations for new journeys was also modelled consistent with PwC estimates. This was that 10% of all trips to the drop off locations are new trips and used a value of 1.6 trips to the supermarket per week per household. This meant that each household has 8.32 new trips to drop off their glass a year.

3. Community Collection Model

A third network option considered is the community collection model. This is where bins are located in all communities around the country. In urban areas these would be in walking distance of every household This is an approach that has been taken in some European countries like Sweden, which have seen collection rates of 90%+.

The major benefit in this model is removing the requirement for household collection trucks. Glass would also be pre-colour separated at these bins, making bin collection very efficient and cost-effective.

As this method requires community participation, the time to drop off the glass is modelled as household time in the same way as the CRS, using a value of $10.63 an hour, and an average walking speed of 5km/h, consistent with Sapere's estimates. The volumes collected at drop off locations are then aggregated to the nearest Hub. This leg is undertaken by a skip collection truck, and the emissions factors and cost are used accordingly. The cost of collections at kerbside and the cost to transport to the Spoke are

57 Container Return Scheme Consultation Document, Appendix Sapere CBA, 2022

58 Container Return Scheme Consultation Document, Appendix PWC financial modelling, 2022

summed to get a total cost, as well as the Spoke to Hub and Hub to beneficiation plant legs of the journey.

Owning this large national network would require a significant outlay. So, similar to the financing model of RVMs in the CRS proposal the community bins follow a lease model for hire and collection. This is also a practical solution as it is a common service and accessible in every region.

The lease model results in ongoing costs, which are not insignificant. If additional capital or loan financing were available, consideration could be given to owning these assets.

Modelling over time showing impacts of scheme targets

Modelling has been done over annual periods. To compare between the three types of collection methods, as well as investigating the scheme targets, years 0, 1, 3 and 5 (steady state) of the system were modelled. To be consistent, we have again modelled an initial 6.5% decrease in glass to market which was forecast by Sapere. For the same reason, from the first year onwards, we have modelled an annual household consumption growth of 0.69% (net of any changes influenced by the scheme).

The scheme targets several improvements in the circularity of glass in New Zealand. Our digital twin applies the impacts to the system of these increasing targets as the scheme is established and delivers better outcomes. This dynamically considers volumes of glass in the market, glass capture rates and the capacity constraint of the infrastructure to produce a cost and emissions scenario to be fed into the cost model.

Table XIV includes modelling outcomes of the scheme initiatives:

- Reducing total glass to market from baseline (in favour low more circular alternative packaging)
- Increasing glass collection rate
- Increasing furnace capacity by addressing bottlenecks and delivering high quality colour-matched cullet
- Reducing losses, and hence
- Increasing bottle-to-bottle rate.

Table XIV Modelling outcomes: Bottle-to-bottle recycling possible through the scheme

	Total glass to market	Glass collection	Furnace capacity	Expected Losses	Bottle to Bottle rate*
Baseline	258,748	194,061(75%)	161,460	>10%	**61%**
Year 1	241,929	193,543(80%)	168,480	6%	**75%**
Year 3	226,405	192,443(85%)	198,900	4%	**81%**
Year 5	219,935	197,942(90%)	210,600	<3%	**87%**

*Glass collection limited by furnace capacity, less losses for glass cullet

Project DCF Model

To compare appropriately between the different collection methods and scenarios over the long run we created a cost model which takes the output from the collection model and extends from the steady state in year five to get a cost of the network over 30 years and discounts back to the present.

This cost model takes the three-point estimates of each of the 5 main costs involved in the collection model (transportation, collection, household cost, crushing cost, infrastructure cost) as well as the revenue gained from end-markets to create distributions. Non-collection costs like managing agency costs are also included with three-point estimates.

We then created a Monte Carlo simulation to sample from the input distributions to create a distribution of the total cost of the network in each year and the discounted value and benefit ratio.

The total costs of the Managing Agency were then divided by the tonnage of glass to market to determine a levy value. This levy can then be spread across every tonne of glass to market to ensure that the cost of recovery for the network is fully covered by the producers.

This is expanded on in the Cost Benefit Analysis section.

Managing Entity

Overview of scheme management and governance

The managing entity is required to be a not-for-profit with public reporting requirements and agreed targets.

We are proposing a Board of Directors made up of industry-voted representatives (non-remunerated) and an Advisory board for advising on recycling and environmental matters (remunerated).

We are proposing a staffing structure of 15 employees with the skills to deliver the scheme and associated benefits.

Entity costing

In considering the cost and overhead structure, we undertook a detailed investigation of cost structures of three overseas examples using publicly available financial disclosures and in-market interviews. These entities were: COEX (QLD, Australia), WA Return Recycle Renew (WA, Australia), and Svensk GlasAtervinning (Sweden). We also reviewed The Packaging Forum and the proposed CRS and their forecast costs and relativity.

Relativity of entity

There were a few aspects considered to ensure appropriate entity costing based relativity with entities undertaking a similar function.

We estimate that the new entity would receive a total annual levy of $42.5m, which is twenty times[59] the levy currently gathered by The Packaging Forum. The Packaging forum does not own, operate recycling assets and the complexity and breadth of supplier arrangements is limited. Consequently, the size of the Managing Agency, and its indirect costs will be required to be greater to manage the greater responsibilities, supplier relationships, complexity, and public scrutiny.

Operating budgets of Australian container return schemes are significantly larger (QLD income of $338m and assets of $80m). For the volume of containers, the breadth of materials and operating infrastructure, the size is a reasonable comparison for a CRS in New Zealand.

Two additional considerations are the infrastructure owned and managed, and the degree of change required.

The managing entity costs would be significantly less than an equivalent CRS managing agency. There is a lower complexity in operating a single-resource product stewardship scheme and there is a significantly lower degree of change required. However, the major reasons are that most of the infrastructure is already used in the current network, and it would be focused on one glass stream – not requiring sorting and processing operations. Many existing collection contracts could be novated (in part) to the scheme. Many agencies internationally operate significant processing infrastructure, and this would also not be required.

For this reason, our primary costing of staff and other managing entity costs have been built from the bottom-up, based on the capabilities required to deliver the outcomes desired.

Staff capabilities required

We have undertaken staff costing based on the capabilities the Managing agency would require, and the roles required to bring that capability.

The expected capabilities are:

- Stakeholder management
- Advocacy
- Marketing
- Procurement
- Contract Management
- Glass recycling expertise
- Operations expertise
- Reporting
- Data collection and analysis
- Finance

[59] $1.9m levy received, The Packaging Forum Annual Report P&L 31 March 2021

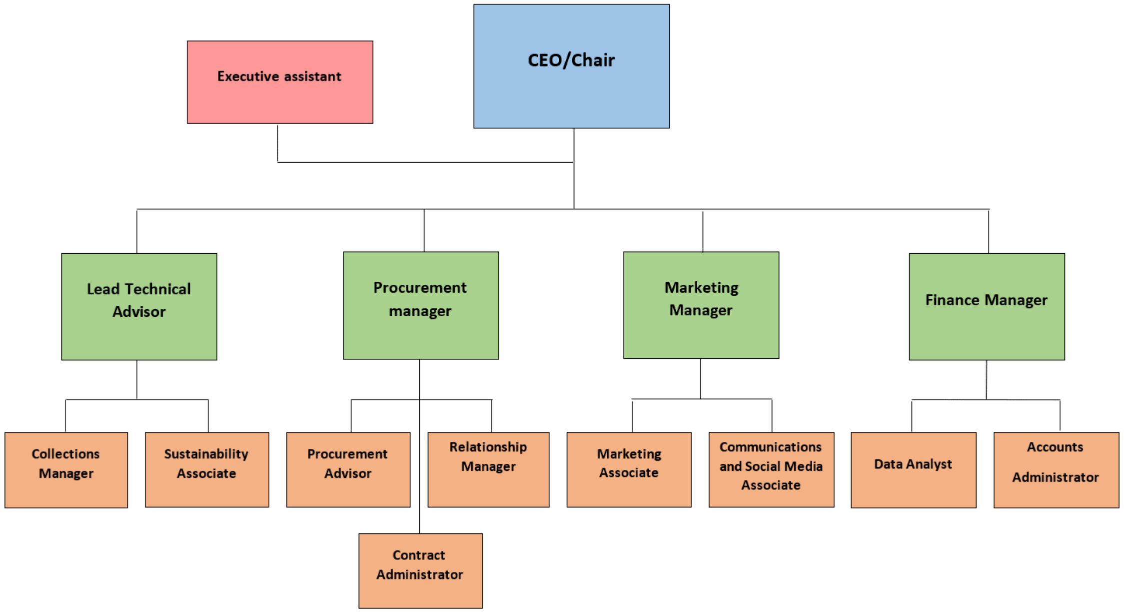
Expected entity costs

Table XV below summarises the expected costs of operating the managing agency.

Table XV Managing agency operating expenses ($m)

Year	Initial	1	2	Ongoing
Administrative and support services	-	$0.1	$0.1	$0.1
Professional services	$1.0	$0.8	$0.8	$0.5
Marketing and communication	-	$1.3	$1.3	$0.3
Employee benefits	$0.5	$1.4	$1.4	$1.9
Other expenses	$0.1	$0.2	$0.2	$0.3
Office lease	-	$0.1	$0.1	$0.1
Total expenses	**$1.6**	**$3.8**	**$3.8**	**$3.1**

Figure 28 Indicative organisational chart, Grant Thornton analysis



Cost Benefit Analysis

Summary of Scheme Operating Performance

Table XVI below provides a summary of the costs, revenue, and glass volume measurements forecasted for years 0, 1, 3 and 5 of the scheme. From year 5 the scheme is expected to reach a steady state, and then we have modelled an annual growth of 0.69% for household consumption of glass.

Table XVI scheme operating summary ($m unless specified)

	Year 0	1	3	5
Costs				
Collection costs	($39.1)	($39.1)	($39.1)	($39.1)
Transport costs	($6.6)	($8.7)	($12.2)	7)
Managing agency operating costs	($1.6)	($3.8)	($3.1)	($3.1)
Transfer facility handling costs	($4.6)	($4.5)	($4.8)	($5.0)
Litter reduction fund	-	($0.4)	($0.4)	($0.4)
Revenue				
Sales to glass manufacturing plant	$14.8	$15.1	$17.6	$18.4
Infrastructure related costs				
Lease of community collection bins	($3.2)	($3.2)	($3.2)	($3.2)
Purchase of kerbside collection bins	($10.9)	-	-	-
One-off increase in bunker capacity	-	($2.0)	-	-
Glass handling infrastructure at hubs	-	($0.2)	-	-
Ongoing bunker improvement	-	($0.5)	($0.5)	($0.5)
Avoided costs				
Council management costs	-	($3.6)	($3.6)	($3.6)
Council processing costs	-	($3.9)	($3.8)	($4.0)
Council costs to transfer glass to landfill	-	($2.0)	($3.7)	($5.1)
Glass volume measurements				
Quantity of glass to market (*000 tonnes*)	259	242	226	220
Quantity of glass collected (*000 tonnes*)	194	194	192	198
Total levy collected	-	$45.0	$45.7	$44.6
Levy per kilo required (*$ per tonne*)	**-**	**$0.19**	**$0.20**	**$0.20**

At year 5 the expected net costs to be covered by a levy is expected to be $44.6 million, with an 80% confidence interval of $40.4 - $48.7 million.

The most significant cost and the most variable across regions is the kerbside collection cost per household. We have modelled a reasonable range based on collection rates currently paid in the market and this is the major factor driving the width of the distribution of net costs. No efficiencies have been assumed for undertaking this service at a national level, but this could result in an eventual outcome towards the bottom end of this range.

Distribution of modelled net costs of a product stewardship scheme (levy required)

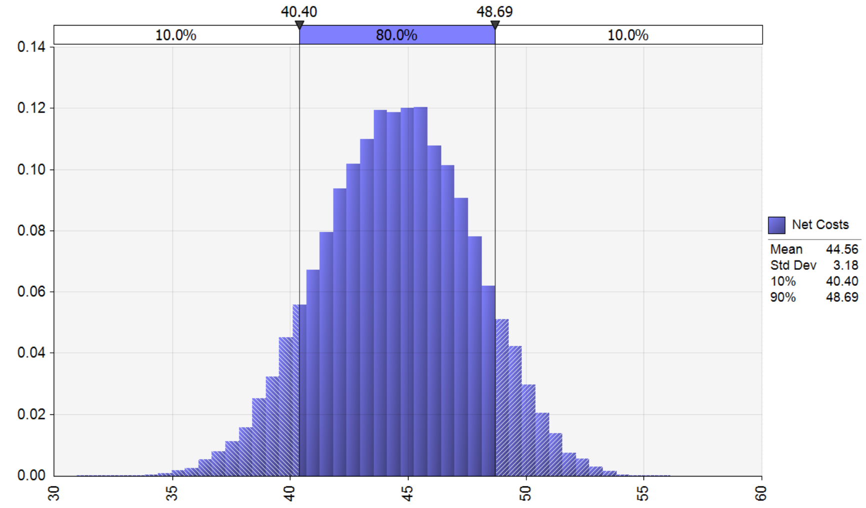


Figure 29 Distribution of total levy required (Year 5 – National Kerbside Model)

Introduction to Scheme Costs

The costs of the scheme come from three main sources:

1. Operation of the collection and transport network;
2. Infrastructure required to collect and aggregate glass; and
3. The costs of operating the managing agency.

Cost of Network Operations

Collection costs

Collection costs were based on initially leveraging the current collection fleet and infrastructure. If a product stewardship scheme was to gain accreditation, there would be existing collection contracts, many of which already deliver the service desired. Costing has been estimated based the best available information from Councils interviewed and does not assume significant cost saving through delivering this service nationally.

The Councils we interviewed provided us with the fees that they pay for waste collection services, and from this we were able to model the kerbside collection costs. Based on the number of households within each Council region, we further estimated a fee per household for urban kerbside collections across the country. This was in a range of $20.24 to $27.38 per household (P5 to P95 estimate levels). This range, while small on a per-household level, is significant overall due to the number of households serviced with the kerbside network but provides a realistic range to apply for total national cost of collection. Differing household densities and topographies would mean each collection area would likely have a different cost to service within this range.

For rural collections, which are done at a community level, we considered the cost to lease collection bins along with the cost to transport collected material from these bins to the spoke-level transfer stations. The total bin lease costs per annum are $3.2m based on a daily (fixed) cost of $10.50 per bin. Collections occur when bins are nearing capacity, so the total cost to transport the collected material varies depending on the volume of glass collected.

Implementation of the scheme would deliver an overall reduction of volume collected over time, kerbside collection costs are fairly consistent as collections contracts are typically fixed contracts, heavily tied to the number of trucks required to deliver the service. We note that a lower total volume could increase the number of households serviced from a collection run and reduce the number of total collection trips required. Lower volumes would allow capacity to cover household growth over time, but we have not modelled a reduction in costs here due to the nature of these contracts and assets.

Since rural collections have a variable component, we have modelled a modest reduction in costs over time as glass to market decrease with the scheme implementation. These costs are broken down in Table XVII below.

Table XVII Kerbside collection cost estimates by collection type ($m)

	Baseline	Year 1	3	5	Households Serviced
Urban	$38.8	$38.8	$38.8	$38.8	1,629,662
Rural	$0.4	$0.4	$0.4	$0.4	518,662
Total	**$39.2**	**$39.2**	**$39.2**	**$39.2**	**2,148,324**

Transport costs

We consulted several participants in the transport and logistics sector to develop an understanding of the methods of transporting collected glass from their primary aggregation points at the spokes to their ultimate destination at the beneficiation plant in Auckland and impacts on cost.

1. Road

For road-based transport, providers typically apply one of two charging mechanisms, either a rate for distance travelled or a rate for time taken, with the cost applied being the largest of the two. Charges quoted are based on a round-trip, which will involve travel to the source from the providers depot, movement of payload from the source to the destination, a return to the source (if, e.g., a container needs to be brought back), and a return to the depot. This would include some allowance for time to load payload at the origin and unload it at the destination, with any additional time required being charged at the hourly rate.

The exception to these mechanisms is transport within metropolitan regions which will have a fixed rate for each trip irrespective of either distance travelled, or time taken.

These rates do not account for fuel consumption and providers will apply a Fuel Adjustment Factor which varies depending on the prevailing cost of fuel. For illustrative purposes, we were advised that a typical FAF is in the 3-5% range, however over the last 12 months when fuel costs have been significantly higher than normal, the FAF has been observed in the 10-20% range.

Table XVIII indicates the values we have used in the modelling of our base case, and the range that we have applied in sensitivity analysis.

Table XVIII Road transport costs modelled

	Most likely	Sensitivity Range (P5 / P95)
Distance-based rate ($ per km)	$4.50	$4.00 - $5.00
Time-based rate ($ per hour)	$130	N/A
Auckland metro rate ($ per trip)	$230	N/A
Fuel adjustment factor (%)	4%	N/A

2. Rail

Charges for rail transport are typically quoted based on the location. The charges are dependent on a combination of both distance to destination and demand for services at that location. Logistics providers will quote a single rate that also includes the container hire, along with transport of the cargo from the source by road to the rail network and to the destination by road again once it has left the rail network. This also includes a time allowance to load the cargo into, and unload it from, the container, with charges applying for additional time taken. We have assumed this to be at the same rate stated above for road transport charges.

While the maximum permissible weight for shipment containers is between 24 and 32 tonnes (depending on the location) the practical limit for loading glass is 20 tonnes due to the manner in which it is loaded. This has an impact on the effective unit cost of transporting material over a certain distance (as shown in Table XIX below). In our modelling we have assumed the practical limit of 20 tonnes for all rail transport, leaving the potential to realise efficiency gains from material loading improvements.

Table XIX Rail transport costs

Hub of origin - rail transport	Trip Cost ($ per trip)	Max Weight (tonnes)	Weight Applied (tonnes)	Distance (km)	Cost per tonne per km ($)
Canterbury	$2,500	32	20	1,074	$0.12
Central	$1,400	30	20	511	$0.14
Hawkes Bay	$1,400	26	20	683	$0.10
Nelson-Marlborough	$2,500	28	20	762	$0.16
New Plymouth	$1,400	26	20	699	$0.10
Otago	$2,500	28	20	1,456	$0.09
Southern	$4,000	24	20	1,572	$0.13
Wellington	$1,400	26	20	644	$0.11

In our design we have opted to transport material from spokes to their respective Hubs by road, and from the Hub to the glass manufacturing plant in Auckland primarily by rail. Specific exceptions to note are below:

1. All the Auckland spokes are based within the metropolitan area of Auckland and thus incur the fixed fee referred to in Table XVII above.
2. Transport from the Waikato and Northern Hubs to Auckland will be carried out by road transport. This avoids double-handling of the glass to be transported, and larger volume trucks on these major routes. This is more efficient due to the proximity of these hubs to Auckland.

We have additionally considered fixed charges that will be incurred. This includes container hire fees required for the Waikato and Northland hubs and booking fees that apply to all container movements.

Cost-effectiveness to transport collected glass from far regions to Auckland

The logistics leg costs to get glass back to the Auckland furnace vary significantly in different regions across the country. This impacts the net value from material collected in different regions. Closer regions deliver glass to the furnace net-positive, while further regions are net-negative (strictly through a cost-lens. Environmental benefit persists returning glass to furnace from any region). While we prioritise getting lower-cost glass to the furnace where there is a capacity limitation, increasing the furnace capacity means more farther away regions supply the furnace and come at a marginal cost increase.

The following worked example shows that further south regions deliver glass at a net-loss, and closer regions deliver a net-profit. Our recommendation remains to return as much glass to the furnace as possible.

Table XX Cost per tonne comparison for different regions

Cost per tonne ($)	Invercargill	Queenstown	Palmerston North
Spoke to hub cost	$5.38	$6.62	$2.39
Hub to glass manufacturing plant cost	$199.92	$125.12	$69.93
Total Cost	**$205.30**	**$131.74**	**$72.32**
Estimated End market value (in Auckland)	**$90**	**$90**	**$90**

In the following section we show that the environmental impact of transporting collected glass back to the furnace is also net-positive (up to 10,000km away from the furnace).

Other cost and revenue components

- For sale of glass cullet into the local end market we have assumed a conservative price of $90 per tonne of glass cullet if delivered to beneficiation plant. Excess cullet above the capacity of the manufacturing facility will be put into local applications, such as roading aggregate without compensation expected. With the scheme addressing the manufacturing facility capacity bottleneck, revenue from glass sold into the local market increases.
- Landfill costs. Our modelling assumes an average cost of $129 per tonne of waste transferred to landfill as per the Sapere report. Based on our scheme targets, the total cost glass currently going to landfill is forecast to reduce from a baseline of $7.8 to $2.7 million in year 5 of the scheme due to higher collections.
- Handling costs. Handing costs have been forecasted to cover the use of infrastructure and effort at each Spoke and Hub. These are existing facilities that the scheme is leveraging, largely Council-owned, but also some private facilities (often contracted to Councils). This has been modelled between $5/T and $20/T for each movement (potentially aggregation through a Spoke *and* a Hub).

Infrastructure Costs

Bins for Kerbside Collections

Table XXI below summarises the infrastructure costs assumed in our model. These costs have been previously detailed in the section titled ‘Scheme infrastructure’.

Table XXI Scheme infrastructure costs ($m)

	Year 0	1	3	5 onwards
Lease of community collection bins	$3.2	$3.2	$3.2	$3.2
Purchase of kerbside collection bins	$10.9	-	-	-
One-off increase in bunker capacity	-	$2.0	-	-
Glass handling infrastructure at hubs	-	$0.2	-	-
Ongoing investment	-	$0.5	$0.5	$0.5
Total expenses	**$14.1**	**$5.9**	**$3.7**	**$3.7**

Managing Agency

The three-point estimates related to the expected operating expenses of the managing agency from year 5 onwards are provided in Table XXII below.

Table XXII Managing agency operating expenses three-point estimates ($m – Year 5 onwards)

Indirect cost	Low	Most likely	High
Administrative and support services	$0.1	$0.1	$0.1
Professional services	$0.5	$0.5	$0.6
Marketing and communication	$0.2	$0.3	$0.3
Employee benefits	$1.7	$1.9	$2.2
Office lease	$0.3	$0.3	$0.3
Other expenses	$0.1	$0.1	$0.1
Total expenses	**$2.8**	**$3.1**	**$3.5**

The agency would likely rely on Contractors to fulfil certain roles as it mobilises over the initial period and support additional effort in transition planning, contracting and other establishment activities.

At year 5 the expected net costs to be covered by a levy is expected to be $3.1 million, with an 80% confidence interval of $3.0 - $3.3 million.

Distribution of modelled managing agency indirect costs

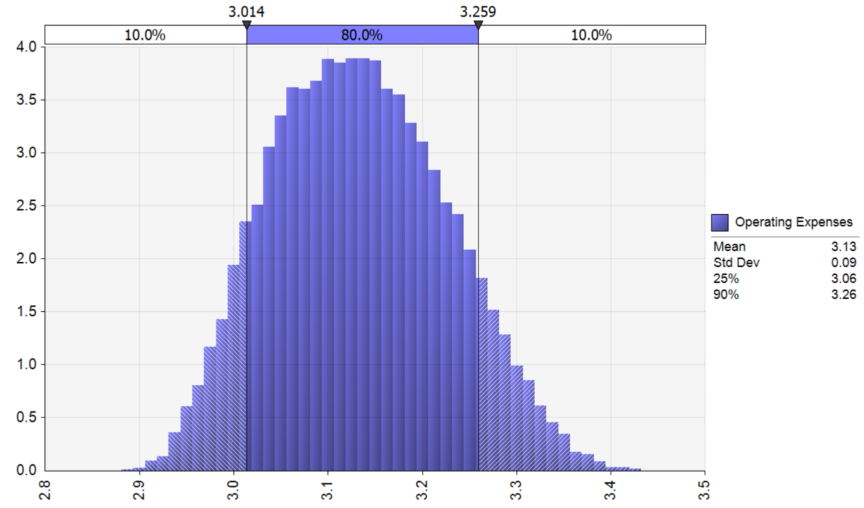


Figure 30 Distribution of Managing Entity Total Operating Expenses (Year 5 – National Kerbside Model)

Levy required to cover cost of scheme

Table XXIII below provides the calculation of the levy required during scheme establishment years and its steady state.

Table XXIII Calculation of levy to cover the cost of the scheme ($m unless specified)

	Year 1	3	5 (Steady State)
Collection costs	($39.1)	($39.1)	($39.1)
Transport costs	($8.7)	($12.2)	($11.7)
Managing agency	($3.8)	($3.1)	($3.1)
Transfer facility handling costs	($4.5)	($4.8)	($5.0)
Included infrastructure costs	($3.7)	($3.7)	($3.7)
Litter reduction fund	($0.4)	($0.4)	($0.4)
Sale of collected glass	$15.1	$17.6	$18.4
Total net costs	**($45.0)**	**($45.7)**	**($44.6)**
Glass to market (*tonnes*)	241.9	226.4	219.9
Levy (*$ per kilo*)	**$0.19**	**$0.20**	**$0.20**

We have modelled the expected range of levy required to meet the entity's net costs by year 5 to be 20.3c per kilo, with an 80% confidence interval of 18.4c – 22.1c per kilo. As with the scheme net costs discussed above, the largest impact on this range is the collection costs, conservatively estimated using a range of values per household currently being paid in the market.

There would be significant value to be realised in the contracting of the collection network and collection optimisation and effective contracting could result in this being at the lower end of this range.

Distribution of modelled scheme levy per kilo of glass

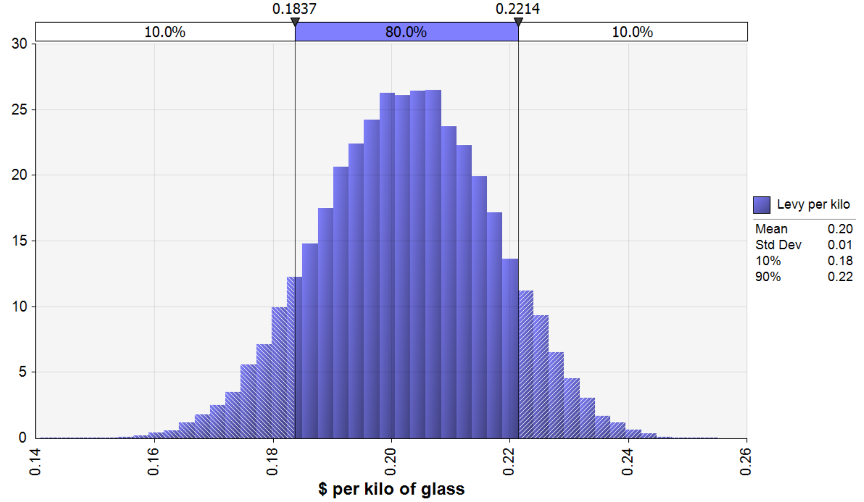


Figure 31 Distribution of the levy required to cover the scheme's net costs (Year 5 – National Kerbside Model)

Cost-Benefit Analysis of Proposed Scheme

The analysis below is based on the real discount rate of 5% p.a. provided by Treasury, over a period of 30 years. This was done to remain consistent with the CBA commissioned by MfE and performed by Sapere. Table XXIV below provides present values of the scheme benefits and additional costs relative to the current state, and the resulting benefit-to-cost ratio (BCR).

Importantly, our benefits do not include any estimated welfare benefits, our benefits represent real benefits to the scheme or Councils.

Table XXIV Cost-benefit analysis of the proposed scheme (PV, $m unless specified)

Year	Ongoing
Benefits	
Decrease in landfill costs	$65.3
Increase in revenue from end market	$61.4
Decrease in Council management costs	$55.9
Decrease in Council processing costs	$51.8
Total benefits	**$234.3**
Costs	
Collection and transport costs	($79.8)
Managing agency operating costs	($48.6)
Purchase of kerbside collection bins	($10.4)
One-off increase in bunker capacity	($1.8)
Additional glass handling infrastructure at hubs	($0.3)
Ongoing bunker improvement	($7.3)
Litter reduction fund	($5.1)
Total costs	**($153.3)**
Net benefits	**$81.0**
BCR	**1.53**

Our modelling is conservative. We have not used any estimated welfare benefits in our modelling. All benefits are real financial benefits to the scheme or Councils

We have modelled an 80% confidence interval of 1.0 to 2.4 for the benefit-cost ratio, with an expected value of 1.53.

Distribution of modelled scheme benefit-to-cost ratio

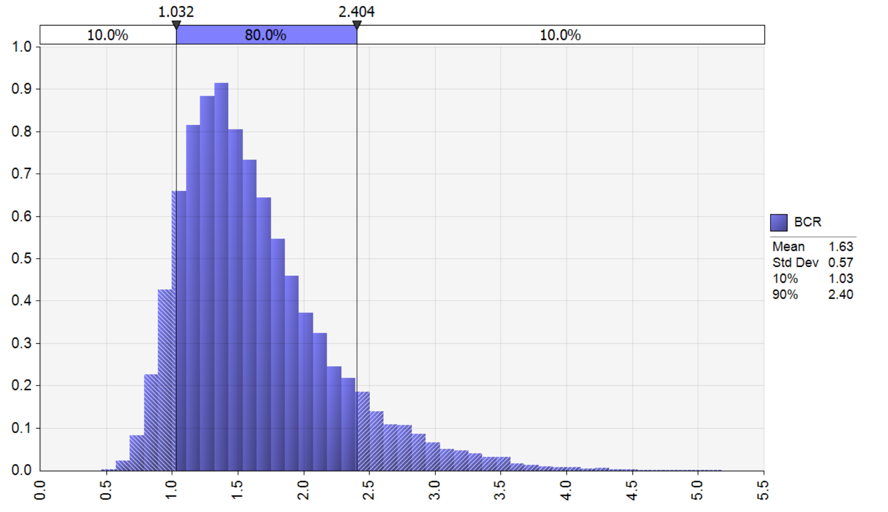


Figure 32 Distribution of possible Benefit-to-Cost Ratios

Impact of Scheme Targets

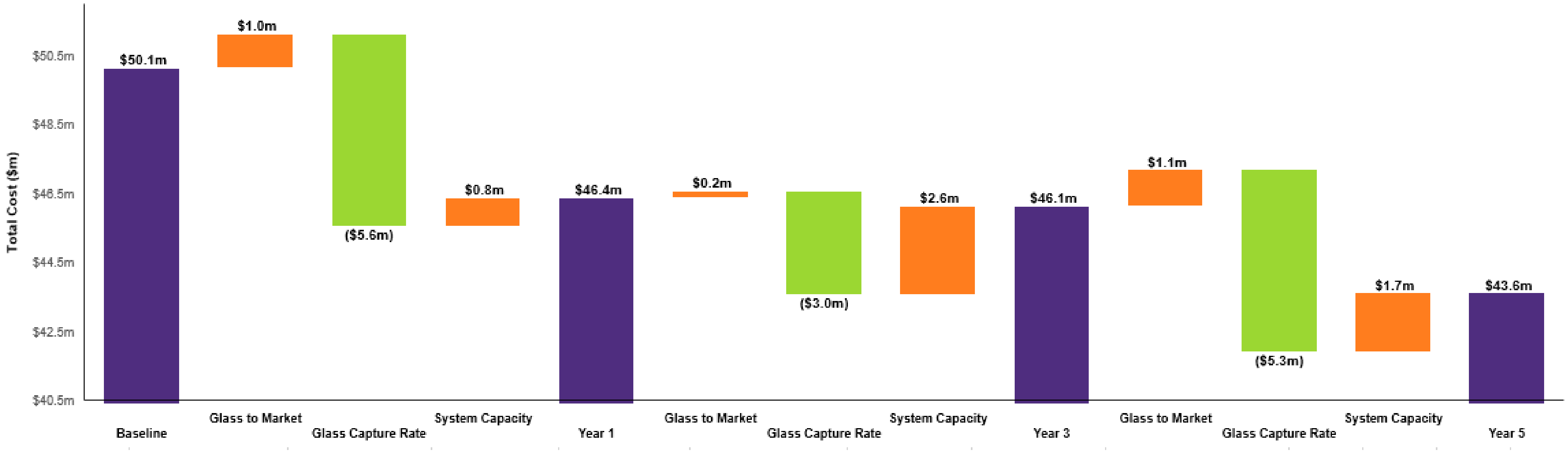


Figure 33 Impact of scheme targets on logistics and landfill cost net of revenue earned

As each of the scheme targets ultimately impact the volume of glass moving through the system there is an impact on both cost and revenue. Figure 33 shows the impact of each scheme target individually, along with changes in furnace capacity, on logistics and landfill costs net of revenue earned. As each element causes a change in the volume of glass transported to Auckland, they also affect where the glass is transported from.

A reduction in the quantity of glass to market creates the opportunity for glass further from the furnace to brought back for bottle-to-bottle recycling. The cost-impact of this on the network is that this volume is returned at a higher marginal cost.

Comparison to CRS

Cost impact comparison

When considering the cost impact of a scheme it is important to consider all elements of cost affecting the price, and their consequential impact on GST. It should be noted that a large part of the forecast CRS' operating budget comes from unreturned bottles, as the managing agency levy itself is not sufficient to cover the costs of the scheme. Therefore, comparing agency levies only is not a like-for-like comparison and a full impact including the deposit must be undertaken.

We have compared the cost impact of the proposed CRS to a product stewardship scheme based on the forecast maximum return rate of 84% of the 20c CRS, shown in Tables XXV and XXVI. The price impact is materially impacted by the ratio of bottles-to-weight due to the different levy applications.

As the comparison shows, the financial impact of the CRS on multi-packs is significant.

The worked example shows that the stewardship scheme will have 50% lower impact on the consumer for a 12-pack of beer.

Table XXV Wine bottle comparison of household cost of CRS and Stewardship scheme

Wine bottle**	Fees paid	GST	**Total cost**	Avg. deposit refund*	**Net cost**
CRS (20c)	23 – 25c	3.5 -3.8c	26.4 – 28.8c	16.8c	9.7 – 12.0c
CRS (10c)	14 – 15c	2.1 – 2.3c	16.1 – 17.3c	8.1c	8.0 – 9.2c
Stewardship scheme	8.8 – 10.5c	1.3 – 1.5c	10.1 – 12.1c	-	10.1 – 12.1c

*Based on the upper end of CRS modelling of 84% return rate for 20c and 81% for 10c

**Based on an average wine glass bottle with weight of 0.476 kg, GS1/IRI weight.

Table XXVI Pack of 12 beers, comparison of household cost of CRS and Stewardship scheme

12-pack of beer**	Fees paid	GST	**Total cost**	Avg. deposit refund*	**Net cost**
CRS (20c)	276 – 300c	41.4 – 45.0c	317 – 345c	201.6c	116 – 143c
CRS (10c)	168 – 180c	25.2 -27.0c	193 – 207c	96.2c	96.0 – 110c
Stewardship scheme	49.0 – 58.9c	7.3 – 8.8c	56.3c – 67.7c	-	56.3 – 67.7c

*Based on the upper end of CRS modelling of 84% return rate for 20c and 81% for 10c

**Based on an average beer bottle of 0.222 kg, GPF data based on recent market insight.

The CRS proposed for New Zealand is fundamentally more capital-intensive requiring investment in infrastructure to support the scheme, due to the new infrastructure required and additional complexity required to operate a CRS of substantial scale. We also note that the CRS deals with packaging that includes material other than glass, therefore requiring greater complexity than managing a single material with a single end market. This results in higher overhead, which is reflected in the operating costs of the managing agency proposed in the financial modelling of the proposed CRS (even when scaled to just compare glass).

As a result, the levy proposed by a glass product stewardship scheme comes in significantly lower than the total impact of what has been proposed for the CRS.

Transport cost

Our analysis included a detailed build-up of the logistics network required to aggregate and transport glass to end markets. Running the CRS collection network through our digital twin of the system showed that our network could deliver the CRS more efficiently than the estimated $112 per tonne forecast in the CRS design, our 80% confidence interval for this cost grouping is $86.1 – $97.6 per tonne, with an expected value of $91.8 per tonne. Where relevant, we used this remodelled transport cost for comparison to other models. However, we have not adjusted the CRS levy for this efficiency when comparing the levies required for alternative scheme designs.

This demonstrates the efficiency of the logistics network designed, which was designed at a much more granular level than the single cost estimate in the CRS design.

Distribution of modelled scheme transport costs per tonne

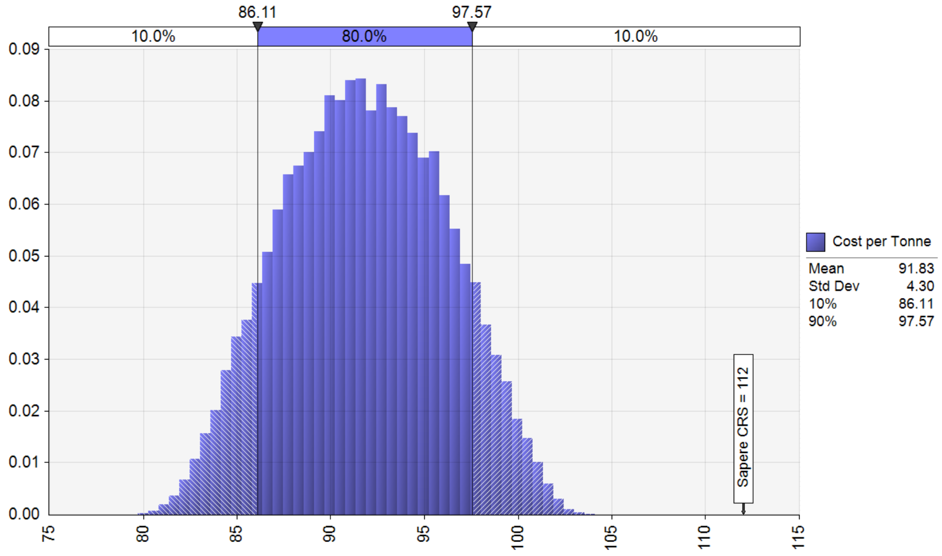


Figure 34 Comparison of logistics costs to the CRS forecast value

Greenhouse Gas Emissions comparison

Reduced emissions from scheme targets

The scheme has targets designed to increase the circularity of the glass recovery network.

We have modelled the effect for the scheme targets to reduce the use of single-use bottles, encouraging refillables, increasing collection and quality of glass recovered and hence percentage of cullet to the glass manufacturing facility.

As the glass lifecycle is an interconnected system, the results of scheme targets lead to flow-on effects throughout the entire system. This is true for the emissions impacts. The total emissions resulting from the achievement of scheme targets have been modelled individually to distinguish the effects between each target.

Emissions are measured in tonnes of carbon dioxide equivalent “tCO2e”.

Reduce single use bottles

Encouraging reduction of single use bottles is the first level of the waste hierarchy and thus has the most significant potential to improve the circularity of glass, and therefore emissions, in New Zealand. This reduction in glass-to-market has been modelled through a reduction in imported glass, and subsequently, a reduction in the quantity of recycling needing to be collected.

Reducing the quantity of imported glass to New Zealand has two primary areas of emissions reduction – in the production of glass (and thus a reduction in raw materials and energy), and in the transport of it to New Zealand.

Looking at imported container glass data, we assigned a nearby glass manufacturing facility to each point of origin and multiplied the emissions factor (for scope 1 & 2 emissions of the furnaces at the facility) by the weight of glass from that location. We then divided the total emissions by the total weight of glass to get an average emissions factor of 0.56 tCO2e per tonne (“tCO2e/t”) of glass manufactured. By comparison, the factor for the Auckland facility is 0.38 tCO2e/t.

Overseas facilities typically produce more emissions than the Auckland facility due to the comparatively high levels of cullet used in New Zealand. Cullet melts at a lower temperature than the raw materials used meaning less energy is needed, and these raw materials (primarily limestone and soda ash) also release carbon dioxide when they react and break down while being melted.

After glass is manufactured, it must be shipped (or in some cases, air freighted)[60] thousands of kilometres to New Zealand. We utilised sea- and air-route calculation tools to determine the distances between the origin and destination of each leg, conservatively using direct routes, meaning the figures are likely understated. We applied MfE emission factors for an average container ship, and short- and long-haul air freight. We then used a weighted average calculation to determine an average emissions factor of 0.76 tCO2e per tonne of glass freighted.

Tallying the emissions factors of 0.56 tCO2e/t of glass manufactured overseas and 0.76 tCO2e/t of glass freighted gives us a combined average of 1.32 tCO2e/t of glass imported.

Table XXVII GHG and scheme targets – reduce single use bottles

	Year One Target:	Year Three Target:	Year Five Target:
Affected system element	**6.5% reduction in glass to market**	**12.5% reduction in glass to market**	**15% reduction in glass to market**
units	tCO_2e	tCO_2e	tCO_2e
Decreased emissions from imports (overseas furnaces and transport)	20,493	44,401	51,232
Decreased emissions from the collection network	89	192	221
Total decreased emissions	20,581	44,593	51,453

60 Statistics NZ, Overseas merchandise trade datasets, March 2022

Importing glass that has been manufactured overseas produces much higher greenhouse gas emissions compared to local manufacturing. This supports a reduction target in single use bottles and incentives to improve emissions profiles of imported goods. A reduction in imports would deliver a disproportionally larger reduction in emissions.

Glass cullet can be transported 10,000km before the emissions benefits of using recycled content in the process are offset by the emissions cost of transporting the cullet to the processing plant[61].

Encourage refillable containers

The use of refillable containers is high up in the waste hierarchy, with 'reuse' sitting just below 'reduce'. Encouraging refillable containers to be used instead of single use glass reduces single use bottles and replaces them with refillable ones, meaning the two scheme targets are closely related and thus have a similar emissions profile.

On average, refillable containers have a lower emissions profile per use than single use bottles as the emissions-heavy production stage of the lifecycle is spread across each use. Typically, the emissions of the transport stage of a use of a refillable bottle are higher than the production stage as a bottle must be transported for each use, whereas the production emissions comparatively reduce every time a unit is reused. Additionally, reusable packaging is generally heavier than single use packaging as it is made with higher quality or more material to be able to withstand many uses, thus increasing fuel requirements for transport.

Despite the larger transport emissions for reusable bottles, the distribution of the production impacts across each use means that they have less of an environmental impact than single use bottles. A meta-study examining 32 LCAs[62] shows the carbon emissions of a reusable glass bottle are 85% less than single use glass. The more times a bottle is used, the more carbon emissions reduce.

Transport distance and method are typically the only major parameters that can lead to a negative environmental outcome for a reusable bottle vs a single use one. As transport (along with less impactful operations such as bottle sterilisation) is the only key lifecycle stage that cannot be reduced with an increase in uses, if the distance is too high, and/or the method of transport is too carbon intensive, the emissions benefit of reuse might never outweigh the cost.

61 Making the most of waste on Aotea Great Barrier 2018, https://infocouncil.aucklandcouncil.govt.nz/Open/2018/12/GBI_20181211_AGN_7987_AT_files/GBI_20181211_AGN_7987_AT_Attachment_64105_1.PDF

62 Patricia Coelho, Blanca Corona, Ernst Worrell, *Reusable vs Single-Use Packaging: A Review of Environmental Impacts,* 2020 https://zerowasteeurope.eu/wp-content/uploads/2020/12/zwe_reloop_executive-summary_reusable-vs-single-use-packaging_-a-review-of-environmental-impact_en.pdf

Increase collection rate and increase glass cullet % in manufacturing

The bottle-to-bottle target mentioned in scheme design is highly related to these two targets, and thus this section just discusses the emissions related to these two targets.

These targets have been combined because an increased collection rate results in an increase of glass cullet available for use in remanufacture. Targeting an increase of cullet in new bottles will increase the end-market demand for collected glass. When combined, these targets result in a greater quantity of glass used in bottle-to-bottle recycling.

Higher percentage of glass cullet used in production leads to a threefold reduction in emissions:

1. The requirement for virgin material extraction and transportation is reduced
2. Glass remelts at a lower temperature than virgin materials, reducing energy input
3. Use of glass cullet avoids the chemical reaction from combining virgin materials which releases carbon dioxide.

Proportionately more cullet in manufacturing reduces the need for raw materials, thus avoiding the need for their extraction and import to New Zealand (predominantly Auckland). Less emissions also result from the virgin materials' in-furnace reaction that releases carbon dioxide.

Based on the composition of the significant raw materials used in glass melting at the glass manufacturing facility, namely silica sand, soda ash and limestone, we determined the average weight used per tonne of glass melted. Multiplying this figure by the appropriate factors we determined the emissions for the extraction and in-furnace chemical reaction per tonne of each material.

Based on the locations where the raw materials are sourced, we calculated distances to Auckland and used raw material weights to determine the total transport emissions, and subsequently emissions per tonne.

Combining the emissions factors for transport, extraction, and in-furnace reaction, we calculated that for a one tonne increase in cullet used, emissions from the extraction, transport and in-furnace reaction of raw materials reduces by 0.3713 tCO2e.

Melting glass requires extremely high temperatures, and to achieve this, the facility in Auckland is fired by natural gas. Electricity is also needed whilst operating the facility but has a comparatively insignificant emissions impact[63]. Glass cullet melts at a lower temperature than virgin materials and so when there is proportionately more cullet used, the energy requirements are less, and thus the emissions associated with energy are reduced.

Melting cullet also does not result in the same chemical reaction as takes place with virgin materials. Higher cullet levels minimise this carbon dioxide release.

Using the total emissions at the facility and dividing by the total tonnes of glass melted, we determined that the facility emissions per tonne of glass melted was 0.27 tCO2e when 67.7% of cullet was used (the proportion used during the same year that the total emissions were measured). According to FEVE, the European Container Glass Federation, for every 10% of recycled glass used in new glass, emissions go down by 5%[64]. Using this relationship, we calculated that on average, for a one tonne increase in cullet used, the glass manufacturing facility emissions decreased by 0.1274 tCO2e.

Adding the raw material and glass manufacturing facility emissions factors, we determined that for every additional tonne of cullet used in local manufacturing, emissions would be reduced by 0.4987 tCO2e.

[63] Personal conversation with glass manufacturing facility operator

[64] Recycling: Why glass always has a happy CO2 ending, FEVE, 2016

Prioritisation of collected glass

The most preferable use of the glass collected in New Zealand is to transport it to the glass manufacturing facility in Auckland to be recycled, due to the decrease in virgin materials required for production. However, the glass manufacturing facility has limited capacity meaning that not all glass collected can be recycled. For the remaining glass that cannot be recycled in New Zealand, we considered three alternative options. These are ranked by their net emissions with the first option having the highest net-positive emissions.

It should be noted that the design of the CRS model does not include options for the use of excess glass captured.

Table XXVIII GHG and scheme targets – priority end of life markets

Option	Offset emissions (-)	New emissions (+)	Net emissions (=)
Units	tCO_2e/t	tCO_2e/t	tCO_2e/t
Export to Brisbane	0.345	0.047	**-0.298**
Export to Sydney via BNE	0.340	0.058	**-0.282**
Export to Melbourne	0.360	0.062	**-0.298**
Export to Adelaide via MLB	0.240	0.077	**-0.163**
Reused in glass wool insulation	0.136	0.031 to 0.048 (rail)	**-0.088 to -0.105 (rail)**
Roading aggregate	0.006	0.001	**-0.005**

The first option was to export the glass to Australia to be recycled where there is demand for cullet. We have selected four cities: Brisbane, Sydney, Melbourne, and Adelaide.

Table XXIX GHG and scheme targets – decreased emissions from the glass manufacturing facility and raw materials

	Year One Targets:	Year Three Targets:	Year Five Targets:
Affected system element	**72% recycled glass in bottles** **80% glass capture rate**	**85% recycled glass in bottles** **85% glass capture rate**	**90% recycled glass in bottles** **90% glass capture rate**
units	tCO_2e	tCO_2e	tCO_2e
Decreased emissions from the glass manufacturing facility	894	2,414	3,537
Decreased emissions from raw materials	2,606	7,038	10,307
Total decreased emissions	3,500	9,452	13,844

We calculated the net emissions per tonne of cullet sent to each of these cities by taking away the transport emissions from the emissions savings associated with increased cullet use in the respective glass manufacturing facilities. The higher the emissions per tonne of glass manufactured at each facility, the more impactful increasing the proportion of cullet is.

There is a direct route to Brisbane from ports in Bluff, Dunedin and Lyttelton. After the ship travels to Brisbane, it also goes to Sydney. For these two cities, we calculated the transport emissions from each of the three New Zealand ports mentioned to Brisbane, and then the additional leg for the trip to Sydney.

The most direct route to Melbourne or Adelaide involved transporting the glass by rail from either Bluff or Dunedin to Lyttelton, and then shipping it to Melbourne, which also continues to Adelaide.

We conservatively used the port furthest away from Brisbane (Port Chalmers in Dunedin) while modelling to Brisbane and Sydney and used the location furthest away from Lyttelton while modelling to Melbourne and Adelaide. This means that transporting from the other locations would result in even further savings, albeit only a few percent.

The second option was to re-use the glass in glass wool insulation[65]. This would require the glass to be transported by rail or shipped from the South Island to the significant manufacturing plant in Auckland. The range of emissions from a starting point of Bluff, Port Chalmers and Lyttelton would be 0.058 to 0.082 tCO2e/t if the glass is shipped, whereas the range of emissions would be 0.031 to 0.048 tCO2e/t if the glass is transported by rail. Due to the lower emissions, rail would clearly be preferable for this option. We then factored in the emissions saving of 0.136 tCO2e/t, resulting from the transport of raw materials that would be replaced by glass in glass wool insulation. This results in a net emissions range of -0.088 to -0.105 tCO2e/t if the glass is transported by rail.

We note there was a second facility for making glass wool insulation in the South Island that has not resumed operation post the Christchurch Earthquake.

We also note that we have not calculated the energy benefit the product delivers through better-insulated homes and reduced heating. Future work is required but it is likely to be a significant benefit in addressing NZ’s shortage of warm, dry homes and could be a considerable contribution to achieving conservation of energy in NZ’s efforts to keep to the Paris Agreement and government commitments.

The third option was to crush the glass and use it in road aggregate. The emissions from crushing the glass would be 0.001 tCO2e/t. There would also be an emission saving of 0.006 tCO2e/t due to the aggregate from quarries being replaced by glass. This results in net emissions of -0.005 tCO2e/t.

Our analysis found that exporting the glass to Australia is the most favourable option environmentally as despite the high emissions from exporting, there is a significant saving in emissions at the increased percentage of recycled glass being used in the facilities in Australia. Importing manufacturing facility. However, it is important to note that this is still significantly less beneficial when compared to transporting the glass to the glass manufacturing facility in Auckland, due to the extra distance required for transport. This option is not currently financially viable due to the high cost of container freight to Australia but will be viable at times in the future.

65 The largest manufacturer in New Zealand is Tasman Insulation, owner of Pink Batts brand.

Summary of total emissions reductions from scheme target

Table XXX summarises the emissions profile from the scheme in years 1, 3 and 5.

Table XXX Summary emissions from scheme targets

	Year 1		Year 3		Year 5	
	Target	Decreased emissions	Target	Decreased emissions	Target	Decreased emissions
units		tCO_2e		tCO_2e		tCO_2e
Reduce single use bottles **(Overseas furnaces and transport, and collection network)**	**6.5% reduction in glass to market**	20,581	**12.5% reduction in glass to market**	44,593	**15% reduction in glass to market**	51,454
Increased collection rate **Increase glass cullet % in furnace** **(Raw materials and furnace)**	**80% glass capture rate** **72% recycled glass in bottles**	3,501	**85% glass capture rate** **85% recycled glass in bottles**	9,452	**90% glass capture rate** **90% recycled glass in bottles**	13,844

Comparison of emissions by scheme

Year 1 comparison between schemes

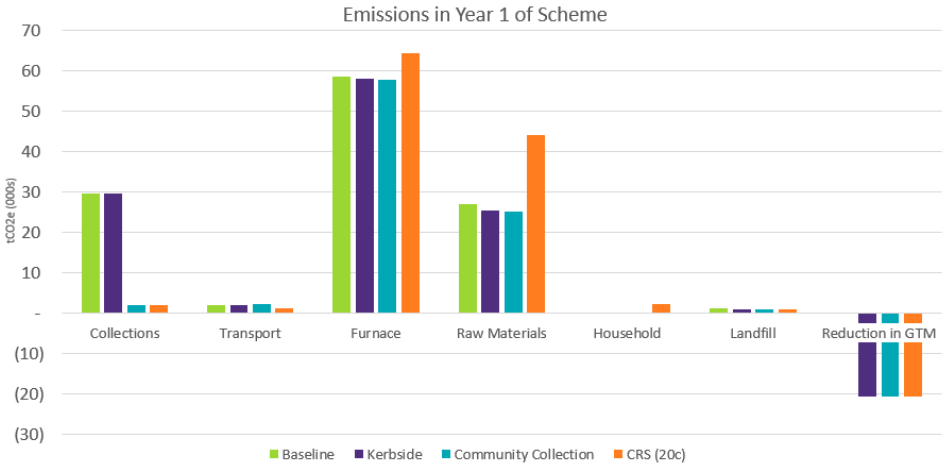


Figure 35 Comparison of emissions for 3 scheme types down the value chain, year one

Collection emissions for the kerbside scheme are significantly higher than a CRS or community collection scheme, as kerbside has a distinct and extensive network to collect from each household. Current collection trucks are very fuel inefficient, as they are heavy and are constantly accelerating and braking and stop at many locations. As shown in Lower Hutt and Palmerston North, a shift towards electrification of collection vehicles would result in a lower emission level in the kerbside model.

The community collection and CRS models have comparatively low collection emissions as they rely on travel largely already undertaken by consumers to drop off glass to aggregation points. The emissions result from the collection from RVMs in the CRS model and from community drop-off points in the community collection scheme.

Transport emissions are an insignificant part of the emissions profile for all schemes, resulting from trucks transporting glass from spokes to hubs and then to the glass manufacturing facility. The schemes able to recycle more glass cullet into bottles have higher emissions in this area as they need to transport more cullet to the furnace, a net positive activity overall.

Furnace emissions are the largest proportion in any scheme and result from the gas and electricity used at the glass manufacturing facility. They are directly related to the amount of cullet that is used in the manufacturing process. Glass cullet melts at a lower temperature than virgin material and so when there is proportionately more cullet used, the energy requirement are less, and thus the emissions associated with gas-powered furnace is reduced.

The emissions in year one are similar for each scheme. The ranking order is a result of the amount and quality of cullet each scheme collects, and the manufacturing facility uses, meaning kerbside and community collection schemes emit similar levels with CRS somewhat higher.

Virgin raw material emissions are also related to the amount of cullet used in manufacturing. Proportionately more cullet used reduces the need for virgin raw materials, thus avoiding the need for their extraction and transport to the glass manufacturing facility in Auckland.

However, the relationship between cullet and raw material emissions is even more pronounced than between cullet and the glass manufacturing facility emissions. This is because cullet replaces raw materials on an almost one-to-one basis, and thus the emissions are reduced at a similar rate.

Additionally, the use of glass cullet also avoids the chemical reaction and subsequent carbon dioxide release from combining virgin materials.

This area is where the scheme targets that result in increased cullet in manufactured glass will have the greatest effect on emissions.

Household emissions are only present for the CRS model due to households driving to the supermarket (or a small number of other locations) to drop off their container glass. This is a relatively insignificant quantity and will theoretically decrease as vehicles become more fuel efficient as hybrid and electric vehicles become more common.

Landfill emissions only result from transportation and landfill-equipment-related emissions, as glass does not biodegrade and release methane. The glass being sent to the landfill is a result of the leftover collected glass that is surplus to the glass manufacturing facility's capacity. While this is an insignificant source of emissions, there are several valuable uses of this excess collected glass.

Reduction in Glass to Market (GTM) emissions savings result from the emissions associated with a decreased quantity of glass imported (as the total amount of glass in the market is reduced). These emissions result from a reduction in the production of glass overseas, translating to a reduction in virgin raw materials and energy, and the transport of it to New Zealand.

The emissions savings are the same for each new scheme, as it is directly related to the shared target (across schemes) of a 6.5% decrease in glass to market in year 1.

Total emissions

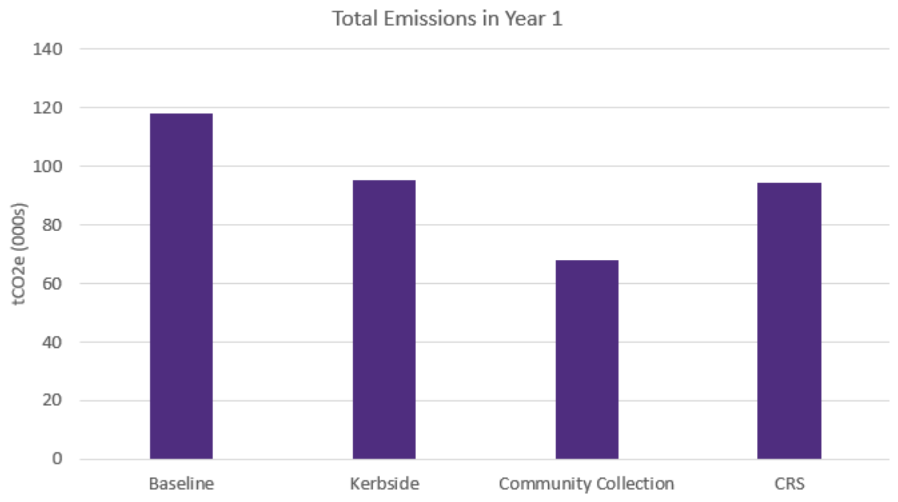
The community collection model has the lowest emissions profile of the three schemes, as it has lower glass manufacturing facility and raw materials emissions than the CRS model, while avoiding significant emissions in the collection stage, unlike the kerbside scheme.

The CRS and kerbside scheme have very similar emissions profiles, with kerbside marginally higher. The kerbside scheme has low glass manufacturing and raw materials emissions but a carbon intense collection method.

The CRS model tops the chart for glass manufacturing facility emissions, and results in significantly more raw material emissions, both relating to the low proportion of quality cullet delivered to the facility and thus demonstrating the importance of increasing the amount of high-quality cullet to significantly influence the emissions-intense sections of the system – the facility and raw materials.

However, the picture changes over time.

Figure 36 Emissions for the three types in year one compared to current baseline



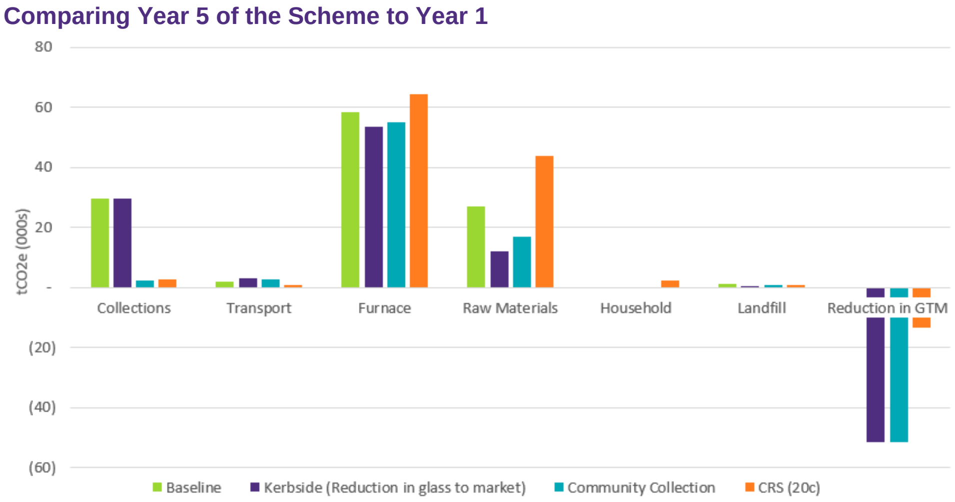


Figure 37 Comparison of emissions for 3 scheme types down the value chain, year five

Collection emissions in the kerbside model are modelled based off the baseline. This is because we have assumed the use the current collection fleet. We note later in this section potential for lower/zero emissions collection in the future. Existing fleets are typically tied to existing collection contracts, the optimal time to improve the fleet is during contracting of collections in a region through specification in the procurement process.

Transport emissions are still relatively insignificant compared to other areas within each scheme and have not changed materially since year one.

Furnace emissions have decreased slightly but are still relatively similar to each other with the kerbside scheme resulting in the lowest, followed by the community collection and then the CRS model. As mentioned, this is related to the amount of cullet used in the manufacturing process, which is associated with what is achievable for each scheme.

Raw material emissions for the CRS model stay relatively constant, with emissions from the community collection and kerbside schemes decreasing, with the latter experiencing a very significant reduction. This is because there is an increase in high-quality cullet used in the glass manufacturing process, reducing the quantity of raw materials required, and the carbon dioxide released during the reaction of the material.

Household and **Landfill** emissions are still relatively insignificant and do not change materially from year one.

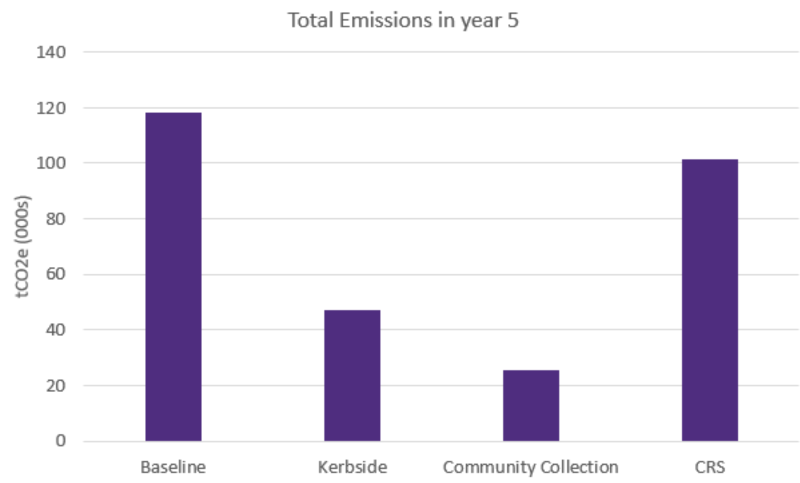
The emissions savings resulting from a **Reduction in Glass to Market** change significantly for each scheme. The savings for kerbside and community collection schemes increase by a factor of approximately 2.5 (reflecting the near 2.5-fold increase in the scheme target of reduced glass to market), while savings for the CRS decrease. The CRS was modelled to have a one-off reduction in glass to market, and then the emissions savings progressively decrease as population growth drives glass demand upward.

Total emissions

The emissions profiles in year 5 for the kerbside and community collections schemes are reduced significantly from year one, while the CRS model increases slightly.

The kerbside scheme results in the lowest emissions overall, followed closely by community collection, with the CRS model producing a significantly larger quantity.

Figure 38 Emissions for the three types in year five compared to current baseline



Scheme emissions over time

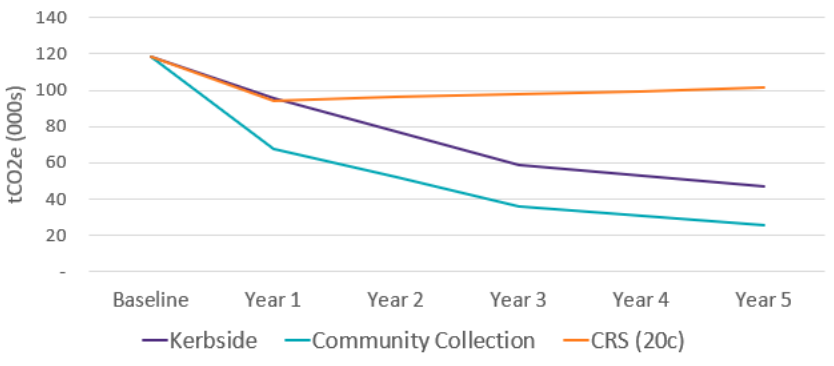


Figure 39 Emissions for the three scheme types over time

Following a significant reduction from the baseline to year 1, total emissions increase slightly for the **CRS** model from year 1 to year 5, primarily due to the reduction in savings from reduced glass to market.

Due to the increase in collection of large volumes of uncontaminated, colour separated glass cullet, leading to high percentages of cullet in manufacturing, the **kerbside** and **community collection** models see significant reductions over time.

The **community collection** model has the lowest emissions profile, with its negligible collection emissions offsetting kerbside's slightly lower furnace and raw material-related emissions.

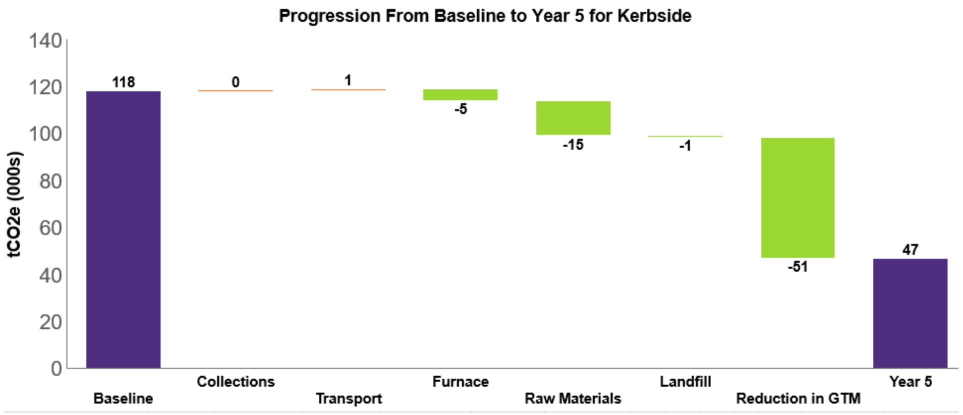
Change from baseline to kerbside in year 5

The difference between the baseline and the kerbside scheme in year 5 is due to two major factors, as shown in Figure 40 below.

The first is that the over time, the kerbside scheme, and associated targets lead to high percentages of cullet in manufacturing, reducing the emissions associated with the glass manufacturing facility (Furnace in Figure 40) and raw materials.

The other major factor is the emissions savings associated with the reduction in glass to market. A decrease in the comparatively emissions-heavy glass manufacturing overseas, and the transport of this glass to New Zealand, is the primary contributor to the change in emissions profile from the baseline to year 5.

Figure 40 Emissions progression from Baseline to Year 5 for Kerbside



Additional comparisons (Year 5)

Kerbside with a reduction in Glass to Market vs no reduction in GTM

The 15% target to reduce glass to market could deliver a 50% saving in the total system emissions in year 5 compared to the same scheme without this target.

This reduction has been modelled by reducing overseas container glass imports – and this imported glass not only has a typically higher emissions cost in manufacturing, but it also has to be shipped to New Zealand as well.

Figure 41 Comparison of impact of reduction of glass to market scheme target

CRS 10c vs 20c deposit rate

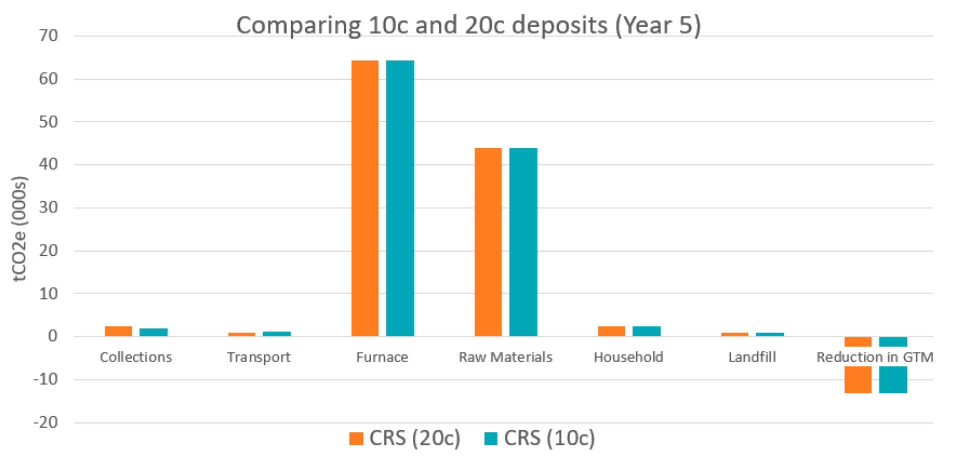
A varying deposit rate of either 10c or 20c does not materially affect the emissions of a CRS as the emissions in the largest emitting scheme areas – the facility and raw material sections – do not change. This is because a CRS delivers low quality cullet and the beneficiation plant can only process cullet at a certain rate, so without increasing the quality of this cullet, the amount of recycled glass used in manufacturing is constrained.

The collection emissions are higher for the 20c rate as more glass is being collected, while the transport emissions are lower as there is more available glass closer to the beneficiation plant.

Landfill emissions are lower for the 20c scheme as it collects more glass, leading to less glass remaining in the system being sent to landfill.

However, the landfill emissions are insignificant compared with the reduction opportunities of the extra glass stockpiled at the 20c rate – it results in approximately 15,000 tonnes of extra glass stockpiled each year that can be recycled or downcycled in the future, compared with the 10c rate.

Figure 42 Comparison of emissions for 10c and 20c deposit schemes in year 5



Considerations for emissions reduction

The two most emissions-heavy areas of the system are the furnace and raw materials, so naturally it would make sense to prioritise the reduction in these areas. However, as the emissions of these two parts of the system are reduced with an increase of glass cullet used in manufacturing, the scheme targets reduce the emissions in these areas by design.

The next highest emitting area is collection in the kerbside model, due to the fuel inefficient collection trucks. There is a significant opportunity for reduction by transition to alternatively powered trucks.

Considering that total kerbside scheme emissions are the lowest of the three schemes and accounting for the opportunity that lies in reducing the collection emissions, the kerbside model has the greatest long-term potential to be the least damaging to the environment.

Section Summary

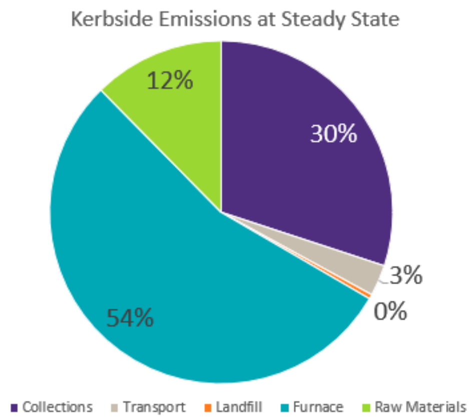
- Emissions will be reduced by design with the achievement of scheme targets
- In year five, kerbside produces the lowest overall emissions with community collection a close second, and CRS significantly higher
- Kerbside has the greatest long-term potential to be the least damaging to the environment, due to its comparatively low emissions and the opportunities for further reduction in the collection fleet.

Opportunities for further reduction

The glass production and collection are resource energy-intensive processes. At baseline the three largest emissions are from the furnace, collection emissions and raw materials emissions.

With the proposed scheme design (as shown in Figure 43) furnace emissions will increase relatively with production fuel to the furnace being the major contributors. There are a number of innovative ways this could be reduced.

Figure 43 Kerbside emissions at steady state year 5



This could include investigating the viability of biogas from landfill and converting fuel source from gas to electric. To address the emissions generated from the proposed increased collection network, there are a couple of proven methods to reduce collection emissions. This is investing in alternative fuel sources: a low-carbon fuel source will reduce operating costs through efficiency and reduced emissions costs for the 58% of emissions produced through fuel combustion[66]. Additionally, a more widely known practice is the conversion to electric vehicles (see case study by Waste Management New Zealand).

While the emissions from raw materials with the designed scheme are significantly lower, there are options to consider reducing these further such as onshore or near-shore sourcing of remaining materials. Silica sand, for example, could be locally manufactured by crushing and processing quartz rock[67]. Local supply of this form has the added benefit of improved assurance over product origin and preventing damage to river, beach and marine ecosystems and social risks to workers and communities in sand extraction sites[68].

[66]BEIS Industrial Fuel Switching Phase 2

[67] FT Machinery, ftmmachinery.com/blog/quartz-stone-how-is-it-processed-and-what-is-it-good-for

[68] UN Environment, Sand and Sustainability: Finding new solutions for environmental governance of global sand resources, 2019

Case Study: Waste Management NZ electric collect vehicles

In 2016, WMNZ committed to reducing emissions from its fleet. They started to transition some of their diesel fleet and invest in cars to help limit climate change and contribute to New Zealand's circular economy.

Today WMNZ operates one of the largest EV truck fleets in Australasia. It also has 93 electric cars in its light fleet. WMNZ's collection trucks each travel an average of 200km per day. Their work is stop-start – the driver stops to empty each bin — which is perfect for electric. At each stop, the deceleration creates energy that recharges the truck's on-board batteries.

To date, one of those electric trucks has driven about 80,000km on duty in Auckland. It runs 11 hours and collects 1200 bins in a day. WMNZ also captures the gas produced from waste at its landfills. This is converted into electricity and supplies the national grid.

In an agreement with EECA, WMNZ developed an electric truck conversion workshop in Auckland. Opened in 2018, the workshop works on WMNZ's fleet, and the company helps other companies in Aotearoa with their EV transition too.

If fully diesel, WMNZ's truck fleet would need 10 million litres of diesel a year. Each electric truck that replaces a diesel-powered vehicle, saves 125 litres of diesel a day. Converting the entire WMNZ fleet would save 100,000 litres of diesel a day.

Staff have been upskilled to drive, maintain, and complete truck conversions in Aotearoa, and manage the fleet's EVs, keeping the company at the forefront of EV technology globally. WMNZ's EV programme now includes 27 fully electric trucks, including trucks in Hutt Valley and Dunedin.

Appendix 1 – Interviewees List

ORGANISATION	INTERVIEWEE	ROLE	INTERVIEW DATE	AREA OF EXPERTISE
5R	Chris Grant	GPF funding recipient and glass processing champion	4 April	Business development/logistics/material processing
ASAHI	Mark Campbell	GPF Steering Committee/Head of corporate affairs	4 April	Third largest percentage of glass to market
ASSOCIATED BOTTLERS CO LTD (ABC)	Philip Barlow	Logistics and supply chain expert	1 April	General Manager. In-depth understanding of logistics and refillables
AUCKLAND COUNCIL	Parul Sood	GM Waste Solutions/ WasteMINZ Board Member	22 April	GM Waste Solutions for NZ's largest metro. Waste Minimisation.
COCA COLA	Clarke Truscott	GPR - Via Grant Thornton Australia	1 April	Head of strategy innovation, new product development and CRS design Lead sustainability function
DB	Sophie Hoult	GPF Member/Corporate Affairs	22 April	Second largest percentage
ENVIROWASTE	Glen Jones	Waste and recycling contractor/GPF Funding Recipient		GM Customers and Sustainability
ENVISION	Warren Snow	GPF funding recipient/ community waste champion	21 April	Community Recycling Champion/articulate business operator
ENVISION	Matthew Luxon	GPF funding recipient/ community waste champion	21 April	Community Recycling Champion/articulate business operator
FULTON HOGAN	Don Chittock	GPF Steering Committee Member/GT - Head of sustainability – South Island and most of North Island	12 April	Materials processing/Environmental Engineering
GORE DISTRICT COUNCIL (CURRENTLY WAKA KOTAHI)	Peter Standring	Problem connecting to network, collect glass and stockpile	20 April	Council. Roading Waste and Water portfolios – big district WITH low rates base.
HASTINGS DISTRICT COUNCIL	Angela Atkins	Solid Waste Manager (Glass out from 2020/GPF Funding recipient)	30 March	Waste Minimisation, Contracts, and behaviour change. Council uses contracted kerbside, rural drop offs and recycling centres. Council moved to glass only crates in 2020

ORGANISATION	INTERVIEWEE	ROLE	INTERVIEW DATE	AREA OF EXPERTISE
HOSPITALITY NZ	Nick Keene	President HNZ and GPF Steering Committee	29 March	Hospitality, people, all things environmental
LION	Sara Tucker	GPF Steering Committee	5 April	Largest percentage of glass to market
LION	Edward Dowse	Lion Director CDS, Director for: Container Exchange (QLD) Ltd, WA Return Recycle Renew Ltd, Marine Stores Pty Ltd	5 April	Container return schemes, Australian return schemes
LION AUSTRALIA	Philippa Perkins	Business Manager CDS	5 April	Business Manager Lion CDS Australia
MARLBOROUGH COUNCIL	Alec McNeill	CRS Working Group Design Manager and MDC Solid Waste Manager. WasteMINZ Board Member	31 March	Joint applicant with Auckland Council to design the CRS. Product Stewardship from academic POV. Recent PHD on Product Stewardship. Local Govt and Waste Minimisation. Practical and trusted opinion
MFE	Roderick Boys	Principal Advisor MFE, CRS Champion	3 May	Local Govt and Landfill from Wellington POV. Ministry conversations around product stewardship
NORTHLAND WASTE	Andrew Sclater	Waste and Recycling Contractor/ GPF funding recipient	3 May	Manager
PALMERSTON NORTH CITY COUNCIL	Natasha Hickmott	Rubbish and Recycling Engineer - Glass out collection early adopter/GPF funding recipient	31 March	In depth understanding of Council Solid Waste challenges and contracts. Council operates own trucks, MRF and material handling
PERNOD RICARD	Monique Sprosen	GPF Chair/Public Affairs	8 April	Large Wine representative
QLD CONTAINERS FOR CHANGE	Ken Noye	CEO Container Exchange (QLD) Ltd	6 May	CEO with in-depth understanding of COEX operation and governance
SMART ENVIRONMENTAL LTD	Yuri Schokking	Waste and Recycling Contractor/GPF funding recipient. GPF steering Committee Member		Contracts Manager and operating from Tasman/Nelson - good overview of contract and challenges around the material flow of glass.
TASMAN DISTRICT COUNCIL	David Stephenson	Glass out Collection	4 April	Engineering and contracts. Council uses kerbside recycling and drop off. The Richmond Transfer Station is a regional hub for glass aggregation
VISY RECYCLING	Penny Garland & Nick Baker	Cullet Manager NZ for Visy Recycling GM Visy Recycling NZ (MRF and Beneficiation)	4 April	Materials processing, cost of material transportation, and supply chain network expert

ORGANISATION	INTERVIEWEE	ROLE	INTERVIEW DATE	AREA OF EXPERTISE
WAITAKI RESOURCE RECOVERY TRUST	Trish Hurley Manager	GPF Funding Recipient, Community Recycling operator	8 April	Grass roots organisation that has been dealing with significant challenges of glass recovery from the Oamaru and surrounding area.
WHANGAREI DISTRICT COUNCIL	David Lindsay	Glass out collection 2019/GPF funding recipient	4 April	Consulting background, in-depth knowledge of Local Govt and contracts. Whangarei moved to separate glass crate in 2019
XTREME ZERO WASTE	Rick Thorpe	Co/General Manager	4 April	Zero Waste expert and practicing champion/CRS supporter
ZERO WASTE NETWORK	Marty Hoffart	Chair of ZWN. CRS champion	5 April	Waste Minimisation/waste auditing and product stewardship SME
FLETCHERS	Michael Burgess	Sustainable Procurement manager	12 April	Flat glass recycling, Pink Batts, Chemistry of glass

Appendix 2 – Documents reviewed

We were informed by a number of documents. Key references are noted in the body of the report. Additional key documentation is noted here.

#	DOCUMENT NAME	AUTHOR
1	NZ Container return scheme CRS final design	Ministry for the Environment
2	NZ Container return scheme draft design appendices	Ministry for the Environment
3	A container return system for New Zealand cost benefit analysis update	Sapere
4	Container return scheme financial modelling report	PWC
5	Container return scheme – snapshot of consultation	Ministry for the Environment
6	Interim regulatory impact statement	Ministry for the Environment
7	Q&As – the container return scheme design project	Auckland Council & Marlborough District Council
8	2020 Global Deposit Book: An Overview of Deposit Systems for One-Way Beverage Containers	Reloop
9	Final reusable packaging factors report	Defra
10	Extended producer responsibility	NZIER
11	Raise the Glass full study	Oakdene Hollins
12	GPF Accreditation Report 2022	Glass Packaging Forum
13	Complete Life Cycle Assessment of North American Container Glass	Glass Packaging Institution
14	Member briefing detail – GPF transition to regulated scheme	Glass Packaging Forum
15	Deposit-Refund System (DRS) FACTS & MYTHS Brochure	Deloitte
16	Reusable vs Single Use Packaging	Reloop
17	DRS Open Letter	British Glass
18	Opportunities For Municipalities In Glass Packaging Collection	ACR
19	Briefing Paper – DRS Report	British Glass

#	DOCUMENT NAME	AUTHOR
20	Boosting closed loop glass recycling in Europe: Say no to DRS Key Messages	Oakdene Hollins
21	Tasmania Container Refund Scheme Explanatory	Tasmanian Government
22	Comparison of collecting glass in kerbside and deposit return scheme	Valpak Consulting
23	Recycle it Right	British Glass
24	Extended producer responsibility – recycling glass right	British Glass
25	Glass Packaging Forum Report – All supermarket glass items	Glass Packaging Forum
26	Glass recycling – an economic perspective	British Glass
27	Packaging survey	Horizon Research
28	EPR Consultation Government response	Department for Environment, Food and Rural Affairs (UK)
29	DRS Slide Deck - A Deposit Return Scheme is not the solution for glass	British Glass
30	Reduction and Recovery Program 2020-2021 Annual Report	NWT Canada Waste
31	Refillable glass containers in Aotearoa New Zealand	Glass Packaging Forum
32	Glass Supply Network – Infrastructure Assessment	Visy Recycling
33	Making the most of waste on Aotea Great Barrier	Zero Waste Network
34	Making Cents: Economic Analysis of Container Deposit/Refund Schemes	KPMG
35	Recycling: Why glass always has a happy CO_2 ending	FEVE
36	Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model	U.S Environmental Protection Agency

Appendix 3 – Glossary

GPF	Glass Packaging Forum
MFE	Ministry for the Environment
MRF	Material Recovery Facility
CRS	Container Return Scheme
DRS	Deposit Return Scheme
EPR	Extended Producer Responsibility
ZWN	Zero Waste Network
SKU	Stock Keeping Unit
ABC	Associated Breweries Co
SU	Single Use
LCA	Life Cycle Assessment
LINZ	Land Information New Zealand
GHG	Greenhouse Gas Emissions
CO_2	Carbon Dioxide Gas
PWC	Price Waterhouse Coopers

TERMS

CONTAINER RETURN SCHEME ALSO KNOWN AS DEPOSIT RETURN SCHEME

A scheme that adds a deposit amount (plus scheme fees) to the purchase price of a beverage container, and is refunded upon return to a drop off facility

END-OF-LIFE

Glass that is no longer capable of performing function for which it was originally made

EXTENDED PRODUCER RESPONSIBILITY

Responsibility on the end- of life of the product is placed on the producer of the material. The product must have significant benefit from reduction, reuse, recycling, recovery, or treatment of the product and that the product can be effectively managed under a product stewardship scheme

GREENHOUSE GAS EMISSIONS

gases that trap heat into the earth's atmosphere

HUB

Location where large quantities of glass are aggregated from spokes to be sent long-haul to the beneficiation plant and furnace in Auckland.

LEVY

A charge to the originators of glass as glass enters the New Zealand market.

LIFE CYCLE ASSESSMENT

Methodology for assessing environmental impacts at each stage of the life cycle of a product.

MANAGING AGENCY

Not for profit organisation that acts on behalf of producers to facilitate the regulated product stewardship

MATERIAL RECOVERY FACILITY

Location that collected Glass can be returned for reproduction and recovery

PRIORITY PRODUCT

A product that has been declared by the Minister in accordance with waste minimisation act 2008. A product that has significant benefit from reduction, reuse, recycle and treatment. The product can also be effectively managed in a product stewardship scheme.

REGULATED PRODUCT STEWARDSHIP SCHEME

A product that has been declared a priority product by Ministry for the Environment and a scheme that is compulsory.

SINGLE USE

Product that cannot be re-used and ends up in landfill if not collected for recycling

SPOKE

Location where glass is aggregated after being collected to be sent to the nearest hub.

Appendix 4 – Managing entity staff costing

Role title	Key capabilities	Role responsibilities	Reports to	Number of roles	Total cost – low (NZD)	Total cost – most likely (NZD)	Total cost – high (NZD)
CEO / Chair	Stakeholder management, leadership, Advocacy	Leading the organisation and Chair of the oversight Board. Responsible for organisational performance and relationships with the Government, MfE, Producers and other interested organisations.	The Board	1	200,000	220,000	250,000
Lead technical advisor	Glass recycling, Advocacy, Reporting	Lead advisor for improving the circularity of glass. Role in performance management of suppliers, assessing infrastructure requirements to improve quality and quantity of glass collected. Advising the CEO on prioritisation of investments, initiatives, and targets.	CEO / Chair	1	126,000	140,000	161,000
Collections manager	Stakeholder management, Advocacy	Collections manager involved throughout the collection network to ensure outcomes are achieved and making refinements to the collections network.	Lead technical advisor	1	160,000	170,000	190,000
Executive assistant	Administration	Assisting the CEO and Managers with administration	CEO / Chair	1	63,000	70,000	80,500
Procurement manager	Procurement, Relationship management	Leading team of staff in Procurement, Contractual Relationships and Contract administration. Objective to drive long term value from contractual relationships, create strong strategic relationships with suppliers and end markets of glass cullet.	Finance Manager or CEO / Chair	1	117,000	130,000	149,500
Procurement advisor	Procurement	Undertaking sourcing activities, supporting the procurement manager with other planning activities	Procurement manager	1	72,000	80,000	92,000
Category/Relationship manager	Relationship management	Relationship managers for contractual relationships, undertaking contract management, performance management and other relationship management activities to get the most long-term value from the contractual relationships	Procurement manager	1	99,000	110,000	126,500
Contract administrator	Contract Administration	Supporting Relationship managers with contract administration, collecting performance management data and reporting	Procurement manager	1	63,000	70,000	80,500

Role title	Key capabilities	Role responsibilities	Reports to	Number of roles	Total cost – low (NZD)	Total cost – most likely (NZD)	Total cost – high (NZD)
Marketing manager	Marketing	Responsible for marketing campaigns, decisions on channel and prioritisation of marketing budget. Also supporting development of the annual report and other documents.	CEO / Chair	1	99,000	110,000	126,500
Marketing associate	Marketing	Supporting the Marketing manager on campaigns, design, and advertisements	Marketing manager	1	72,000	80,000	92,000
Communications and Social media associate	Communications, social media	Communications advisor supporting public statements and content on the website	Marketing manager	1	81,000	90,000	103,500
Finance Manager	Financial reporting	Financial reporting of the entity, supporting auditors with auditing of the accounts and oversight of the levy calculation and billing.	CEO / Chair	1	126,000	140,000	161,000
Accounts administrator	Accounts payable, Accounts receivable	Running Accounts payable for suppliers and Account receivable for Levy collection and glass cullet sales	Finance Manager	1	63,000	70,000	80,500
Data analyst	Data collection, Data analysis	Data collection of various volume, weight-to-market, emissions and counts across the network. Producing reports and analysis to help senior staff with decision making.	Finance Manager	1	81,000	90,000	103,500
Sustainability associate	Emissions reporting, Initiative generation, Options analysis	Emissions and benefit reporting, generating, and improving initiatives, and undertaking options analysis for emissions on logistics and end markets	Lead technical advisor	1	90,000	100,000	115,000
Advisory group	Glass recycling	Advisory group roles, advising the Board and Executive on matters relating to Circularity of glass. Meeting quarterly.	N/A	4	16,000	24,000	40,000
ACC					1.2%	1.2%	1.2%
Kiwisaver					3%	3%	3%
Annual leave - 8%					8%	8%	8%
Total staff cost					**1,714,416**	**1,900,668**	**2,190,144**

Appendix 5 – Proposed Hub locations

Hub	Site	Volume p.a. (tonnes)	Spoke connections
Auckland	Visy Recycling	75,633.49	19
Hawkes Bay	Redclyffe Transfer Station	9,249.12	5
Central	Awapuni Resource Recovery Park	12,283.99	5
Waikato	Hamilton Transfer Station	31,488.88	11
Wellington	Wellington Southern Landfill	13,913.04	4
Northland	Whangarei Re:Sort	9,467.98	9
Canterbury Hub	5R Solutions	25,327.77	12
Otago	Waste Management Dunedin Transfer Station	9,318.51	7
Nelson-Marlborough	Blenheim Waste Sorting Centre	6,919.06	6
New Plymouth	Stratford Transfer Station	6,003.93	3
Southern	Invercargill Transfer Station	5,742.77	4

Appendix 6 – Proposed Spoke locations

Spoke	Site	Hub connection	Volume p.a. (tonnes)	Kerbside households	Rural collection points
Amberley	Amberley Transfer Station	Canterbury Hub	389	1240	6
Ashburton	Ashburton Resource Recovery Park	Canterbury Hub	1701	9372	10
Auckland - North Shore	North Shore Refuse Transfer Station	Auckland	3423	24240	3
Auckland - Upper Harbour	Constellation drive Refuse Transfer Station	Auckland	6970	58643	0
Auckland - Waitākere	Waitākere Refuse and Recycling Transfer Station	Auckland	8901	68802	6
Auckland - Avondale	Envirowaste Patiki Road Resource Recovery Centre	Auckland	3802	31988	0
Auckland - Papakura	Papakura Transfer Station	Auckland	4239	35666	0
Great Barrier	Claris Landfill	Auckland	153	0	2
Auckland - East	East Tāmaki Refuse Transfer Station	Auckland	7891	66398	0
Auckland - Central	Envirowaste Pikes Point Transfer Station	Auckland	18896	158510	1
Auckland - South	Wiri Transfer Station	Auckland	5473	46050	0

Spoke	Site	Hub connection	Volume p.a. (tonnes)	Kerbside households	Rural collection points
Balclutha	Southern Recycling Ltd	Otago	594	2190	13
Beachlands-Pine Harbour	Whitford Transfer Station	Auckland	1217	5151	9
Blenheim	Blenheim Waste Sorting Centre	Nelson-Marlborough	1316	13869	0
Cambridge	Cambridge Recycling Centre	Waikato	3280	22556	14
Christchurch - North	EcoDrop Styx Mill	Canterbury Hub	2713	31073	1
Christchurch - East	EcoDrop Metro	Canterbury Hub	6137	71802	10
Christchurch - Central	EcoDrop Parkhouse	Canterbury Hub	6217	73158	1
Coromandel	Coromandel Town Refuse Transfer Station	Auckland	374	0	4
Dannevirke	Dannevirke Transfer Station	Central	375	2771	2
Dargaville	Dargaville Recycling	Northland	410	0	13
Dunedin	Waste Management Dunedin Transfer Station	Otago	2744	36533	0

Spoke	Site	Hub connection	Volume p.a. (tonnes)	Kerbside households	Rural collection points
Geraldine	Geraldine Transfer Station	Canterbury Hub	487	1528	13
Gisborne	Gisborne Recycle & Refuse Transfer Station	Hawkes Bay	2076	14497	6
Gore	Gore Transfer Station	Southern	2105	4476	27
Greymouth	Smart Environmental Greymouth	West Coast	315	5633	0
Hamilton - North	Envirowaste Sunshine Avenue Transfer Station	Waikato	4310	40191	4
Hamilton - South	Hamilton Transfer Station	Waikato	3012	33017	0
Hastings	Henderson Road Refuse Transfer Station	Hawkes Bay	3127	23597	8
Stratford	Stratford Transfer Station	New Plymouth	708	7830	0
Hibiscus Coast	Econowaste Transfer Station & Resource Recovery Centre	Auckland	3569	26120	3
Hikurangi	Hikurangi Transfer Station	Northland	848	132	5
Huntly	Metro Waste	Waikato	855	3365	4
Invercargill	Invercargill Transfer Station	Southern	1622	22668	0

Spoke	Site	Hub connection	Volume p.a. (tonnes)	Kerbside households	Rural collection points
Kaikohe	East West Waste	Northland	880	0	17
Kaitaia	Kaitaia Recycle Station	Northland	1235	0	19
Kerikeri	Northland Waste	Northland	1496	4827	17
Lower Hutt	Seaview Recycle & Transfer Station	Wellington	3451	44167	0
Mangawhai Heads	Hakaru Re:Sort	Northland	1022	2415	20
Masterton	Masterton Recycling Centre	Central	1580	14801	1
Mosgiel	Green Island Landfill	Otago	1904	15978	26
Motueka	Motueka Resource Recovery	Nelson-Marlborough	797	3785	7
Napier	Redclyffe Transfer Station	Hawkes Bay	2888	29411	0
Nelson	York Valley Landfill	Nelson-Marlborough	1710	18549	0
New Plymouth	Envirowaste New Plymouth Transfer Station	New Plymouth	4199	30909	15
Ngunguru	On The Road Recycling	Northland	374	0	6
Oamaru	Waitaki Resource Recovery Trust	Otago	1541	7062	24

Spoke	Site	Hub connection	Volume p.a. (tonnes)	Kerbside households	Rural collection points
Ohakune	Ohakune Recycling Centre and Secondhand Store	New Plymouth	1097	1955	20
Omarama	Omarama Transfer Station	Otago	278	0	21
Oxford	Oxford Transfer Station	Canterbury Hub	1014	0	20
Palmerston North	Envirowaste Palmerston North Transfer Station	Central	5245	43923	33
Picton	Picton Refuse Transfer Station	Nelson-Marlborough	1125	3103	16
Porirua	Porirua City Council - Spicer Landfill	Wellington	3030	37588	0
Pukekohe	Pukekohe Transfer Station	Auckland	2920	12618	11
Queenstown	Frankton Transfer Station	Southern	1724	8302	18
Rangiora	Southbrook Resource Recovery Park	Canterbury Hub	1931	17057	6
Richmond	Richmond Transfer Station	Nelson-Marlborough	1657	12032	12
Riverhead	Green Gorilla Riverhead	Auckland	1808	7010	7
Rolleston	Pines Resource Recovery Centre	Canterbury Hub	2068	15681	12
Rotorua	Waste Management Rotorua Recycle & Transfer Station	Waikato	3331	28758	20
Tākaka	Tākaka Resource Recovery Centre	Nelson-Marlborough	314	0	6
Taupō	Taupō Landfill & Transfer Station	Waikato	2697	16940	21
Tauranga - Central	Maleme Street Transfer Station	Waikato	4467	36146	3
Tauranga - Mount	Te Maunga Transfer Station	Waikato	3382	28354	5
Te Anau	SDS Recycling Depot	Southern	292	0	13
Te Kuiti	Waitomo District Landfill	Waikato	1210	560	18
Thames	Thames Refuse Transfer Station	Auckland	1066	4072	13
Timaru	Southern Recycle	Canterbury Hub	1567	14264	23
Upper Hutt	Upper Hutt Recycling Station	Wellington	2180	19883	24
Waiheke West	Waiheke Community Resource Recovery Park	Auckland	824	5772	1
Waihi	Waihi Transfer Station	Waikato	2241	15185	16
Waipu	Uretiti Recycling Centre	Northland	969	0	18

Spoke	Site	Hub connection	Volume p.a. (tonnes)	Kerbside households	Rural collection points
Waipukurau	Waipukurau Transfer Station	Hawkes Bay	856	0	17
Wairoa	Smart Environmental Wairoa	Hawkes Bay	302	0	11
Waiuku	Waiuku Zero Waste	Auckland	977	3780	7
Wanaka	Wastebusters in Wanaka	Otago	1226	8184	11
Warkworth	Mahurangi Wastebusters, Community Recycling Centre	Auckland	1417	5054	16
Wellington	Wellington Southern Landfill	Wellington	5252	60194	0
Westport	Smart Environmental Buller	Canterbury Hub	716	2664	26
Whakatāne	Whakatāne Transfer and Recycling Centre	Waikato	2704	13606	12
Whanganui	Midtown Transfer Station & Recycling Depot	Central	2042	21379	9
Whangārei	Whangārei Re:Sort	Northland	2235	20354	0
Whitianga	Whitianga Refuse Transfer Station	Auckland	1713	7221	19

Appendix 7 – Proposed Rural collection points

Rural collection location (town)	Number of collection points	Spoke connection	Volume p.a.	Households
Ahipara	2	Kaitaia Recycle Station	96.194593	714
Akaroa	3	Little River Recycling Depot	118.12606	1137
Algies Bay	1	Mahurangi Wastebusters, Community Recycling Centre	105.49567	708
Allanton	1	Green Island Landfill	18.082735	192
Amberley Beach	1	Amberley Transfer Station	13.698165	129
Anakiwa	1	Picton Refuse Transfer station	19.149333	161
Aramoana	2	Waste Management Dunedin Transfer Station	11.207529	119
Arapuni	1	Cambridge Recycling Centre	13.66829	175
Arthurs Pass	1	Smart Environmental Greymouth	14.050087	134
Arthurs Point	2	Frankton Transfer Station	70.737555	511
Ashley	1	Southbrook Resource recovery park	18.945416	189
Athenree	1	Waihi Transfer Station	39.193071	498
Ātiamuri	1	Taupō Landfill & Transfer Station	12.486241	101
Awanui	1	Kaitaia Recycle Station	25.867454	192
Baddeleys Beach-Campbells Beach	1	Mahurangi Wastebusters, Community Recycling Centre	24.43685	164
Balfour	1	Gore Transfer Station	9.94274	123
Bannockburn	1	Parkburn Quarry	36.468603	310
Baylys Beach	1	Dargaville Recycling	25.795577	306
Benneydale	1	Waitomo District Landfill	19.479106	156
Bethells Beach	1	Waitākere Refuse and Recycling Transfer Station	26.224912	176
Birdlings Flat	1	Little River Recycling Depot	19.739623	190
Blackball	2	Smart Environmental Greymouth	13.398026	243
Bluff	1	Invercargill Transfer Station	116.179964	1295
Brighton	2	Green Island Landfill	71.012408	754
Brightwater	2	Richmond Transfer Station	96.672879	892
Bulls	2	Envirowaste Palmerston North Transfer Station	93.537195	979
Bunnythorpe	1	Envirowaste Palmerston North Transfer Station	31.477215	322
Burnham Camp	1	Pines Resource Recovery Centre	41.835707	399

Carters Beach	1	Smart Environmental Buller	19.783929	207
Castle Hill	1	Oxford Transfer Station	36.697988	350
Castlepoint	1	Masterton Recycling Centre	24.577395	198
Cheviot	1	Culverden Transfer Station	29.201515	275
Clarks Beach	2	Waiuku Zero Waste	113.690956	763
Clevedon	1	Whitford Transfer Station	47.383649	318
Clinton	1	Southern Recycling Ltd	15.813589	171
Clive	1	Henderson Road Refuse Transfer Station	105.886709	878
Coalgate	1	Oxford Transfer Station	33.657298	321
Collingwood	1	Takaka Resource Recovery Centre	24.818486	229
Cooks Beach-Ferry Landing	3	Whitianga Refuse Transfer Station	176.194623	1186
Coopers Beach	2	Kaitaia Recycle Station	80.835793	600
Coromandel	3	Coromandel Town Refuse Transfer Station	187.931027	1265
Culverden	1	Culverden Transfer Station	26.759206	252
Cust	1	Oxford Transfer Station	19.246137	192
Darfield	4	Oxford Transfer Station	157.80135	1505
Dargaville	5	Dargaville Recycling	191.696542	2274

Diamond Harbour	3	EcoDrop Metro	123.736269	1191
Dobson	2	Smart Environmental Greymouth	15.824006	287
Doyleston	1	Pines Resource Recovery Centre	18.873251	180
Dunsandel	1	Pines Resource Recovery Centre	24.640078	235
Duntroon	1	Waitaki Resource Recovery Trust	8.44152	102
Duvauchelle	1	Little River Recycling Depot	33.97293	327
Edendale	1	Gore Transfer Station	32.980796	408
Egmont Village	1	Envirowaste New Plymouth Transfer Station	17.787667	162
Eketāhuna	1	Envirowaste Palmerston North Transfer Station	36.561953	362
Ettrick	1	Green Island Landfill	12.352269	105
Fairlie	2	Geraldine Transfer Station	61.053838	599
Featherston	3	Upper Hutt Recycling Station	147.799463	1369
Fox Glacier	2	Smart Environmental Greymouth	10.907477	101
Foxton	3	Envirowaste Palmerston North Transfer Station	145.318834	1490
Foxton Beach	4	Ōtaki Refuse Transfer Station	160.338365	1644
Franz Josef	2	Smart Environmental Greymouth	23.75886	220
Frasertown	1	Smart Environmental Wairoa	13.713371	200

Glenavy	1	Waitaki Resource Recovery Trust	25.249884	165
Glenbrook Beach	1	Waiuku Zero Waste	23.691824	159
Glenorchy	1	Frankton Transfer Station	48.45038	350
Glentunnel	1	Oxford Transfer Station	15.413155	147
Governors Bay	1	EcoDrop Metro	51.219127	493
Grahams Beach	1	Envirowaste Pikes Point Transfer Station	42.168467	283
Grovetown	1	Blenheim Waste Sorting Centre	24.263751	204
Hahei	2	Whitianga Refuse Transfer Station	88.542998	596
Halcombe	1	Envirowaste Palmerston North Transfer Station	25.147416	237
Hampden	1	Waitaki Resource Recovery Trust	23.338321	282
Hamurana	2	Waste Management Rotorua Recycle & Transfer Station	55.998326	515
Hanmer Springs	3	Culverden Transfer Station	158.112928	1489
Haruru	2	Northland Waste	74.907834	556
Harwood	2	Waste Management Dunedin Transfer Station	16.293298	173
Haumoana	2	Henderson Road Refuse Transfer Station	61.747147	512
Havelock	1	Picton Refuse Transfer Station	45.554003	383
Hawarden	1	Culverden Transfer Station	19.963217	188
Hāwea Flat	1	Wastebusters in Wanaka	31.146673	225
Hicks Bay	1	Whakatāne Transfer and Recycling Centre	14.424915	113
Hikurangi	2	Hikurangi Transfer Station	82.876347	602
Himatangi Beach	1	Envirowaste Palmerston North Transfer Station	51.674226	487
Hinds	1	Ashburton Resource Recovery Park	20.057506	160
Hiwinui	1	Envirowaste Palmerston North Transfer Station	13.369512	126
Hokio Beach	1	Ōtaki Refuse Transfer Station	25.455178	261
Hope	1	Richmond Transfer Station	36.089763	333
Hororata	1	Pines Resource Recovery Centre	11.953059	114
Horotiu	1	Envirowaste Sunshine Avenue Transfer Station	31.269744	260
Huia	1	Waitākere Refuse and Recycling Transfer Station	53.343856	358
Hunterville	1	Midtown Transfer Station & Recycling Depot	26.370037	276
Jacks Point	4	Frankton Transfer Station	264.262216	1909
Kaeo	1	Northland Waste	14.819895	110
Kai Iwi	1	Midtown Transfer Station & Recycling Depot	10.054356	115
Kaiaua	1	Thames Refuse Transfer Station	28.253175	297

Kaikohe	4	East West Waste	218.795545	1624
Kaikōura	1	Blenheim Waste Sorting Centre	308.443863	1803
Kaimaumau	1	Kaitaia Recycle Station	16.301885	121
Kaingaroa	1	Waste Management Rotorua Recycle & Transfer Station	20.659577	190
Kaitaia	5	Kaitaia Recycle Station	316.876307	2352
Kaiteriteri	2	Motueka Resource Recovery	62.642291	578
Kaiwaka	1	Hakaru Re:Sort	30.179139	358
Kaka Point	1	Southern Recycling Ltd	28.667909	310
Karangahake	1	Waihi Transfer Station	16.552365	174
Karapiro Village	1	Cambridge Recycling Centre	12.613693	131
Karekare	1	Waitākere Refuse and Recycling Transfer Station	29.503026	198
Karikari	1	Kaitaia Recycle Station	111.014489	824
Karitane	1	Waste Management Dunedin Transfer Station	43.605763	463
Kaukapakapa	1	Green Gorilla Riverhead	52.89684	355
Kawakawa	2	Northland Waste	86.494298	642
Kawakawa Bay	1	Whitford Transfer Station	49.320716	331
Kawau Island	1	Mahurangi Wastebusters, Community Recycling Centre	24.734861	166
Kawhia	1	Waitomo District Landfill	68.73194	451
Kerepehi	1	Thames Refuse Transfer Station	25.779833	271
Kihikihi	3	Cambridge Recycling Centre	133.358506	1385
Kimbolton	1	Dannevirke Transfer Station	14.961121	141
Kingseat	1	Pukekohe Transfer Station	20.562715	138
Kingston	1	Frankton Transfer Station	47.342943	342
Kinloch	3	Taupō Landfill & Transfer Station	152.554665	1234
Koitiata	1	Midtown Transfer Station & Recycling Depot	11.465233	120
Kumara	1	Smart Environmental Greymouth	20.411021	189
Kuratau	2	Taupō Landfill & Transfer Station	85.425667	691
Kurow	1	Waitaki Resource Recovery Trust	26.069401	315
Lake Hāwea	3	Wastebusters in Wanaka	160.993692	1163
Lake Hayes	5	Frankton Transfer Station	311.328299	2249
Lake Hood	1	Ashburton Resource Recovery Park	32.593448	260
Lake Ōkāreka	1	Waste Management Rotorua Recycle & Transfer Station	31.315569	288
Lake Tarawera	1	Waste Management Rotorua Recycle & Transfer Station	52.736288	485
Lawrence	1	Southern Recycling Ltd	31.997086	346

Leithfield	1	Amberley Transfer Station	27.608705	260
Leithfield Beach	1	Amberley Transfer Station	25.484958	240
Lepperton	1	Envirowaste New Plymouth Transfer Station	21.740482	198
Little River	1	Little River Recycling Depot	18.908481	182
Luggate	1	Wastebusters in Wanaka	38.206585	276
Lumsden	2	Gore Transfer Station	43.004372	532
Mahia Beach	2	Smart Environmental Wairoa	42.237184	616
Malvern Hills-Whitecliffs	1	Oxford Transfer Station	14.679195	140
Manaia	1	Egmont Refuse & Recycling	87.422428	709
Manakau	1	Ōtaki Refuse Transfer Station	24.967531	256
Manapouri	1	SDS Recycling Depot	26.675644	330
Mangakino	2	Taupō Landfill & Transfer Station	97.911908	792
Mangawhai	2	Hakaru Re:Sort	58.756592	697
Mangōnui	1	Kaitaia Recycle Station	61.704655	458
Manutuke	1	Gisborne Recycle & Refuse Transfer Station	23.998974	188
Māpua	2	Richmond Transfer Station	71.204127	657
Maraetai	3	Whitford Transfer Station	159.882563	1073
Mārahau	1	Motueka Resource Recovery	23.409576	216
Marlborough Ridge	1	Blenheim Waste Sorting Centre	16.532654	139
Matapouri	1	On The Road Recycling	50.661953	368
Matarangi	4	Whitianga Refuse Transfer Station	241.11625	1623
Mataura	2	Gore Transfer Station	83.07831	907
Maungatapere	2	Whangārei Re:Sort	14.868182	108
Medlands Beach	1	Claris Landfill	28.45999	191
Methven	3	Ashburton Resource Recovery Park	128.61876	1026
Millbrook	1	Frankton Transfer Station	36.54543	264
Mokau	1	Motueka Resource Recovery	29.967855	240
Mossburn	1	Gore Transfer Station	12.771975	158
Motuoapa	2	Taupō Landfill & Transfer Station	74.42294	602
Mount Somers	1	Ashburton Resource Recovery Park	15.419208	123
Muriwai	2	Green Gorilla Riverhead	86.274002	579
Murupara	2	Waste Management Rotorua Recycle & Transfer Station	108.951978	915
National Park	1	Ohakune Recycling Centre and Secondhand Store	51.736493	347
Ngatea	2	Thames Refuse Transfer Station	69.348703	729

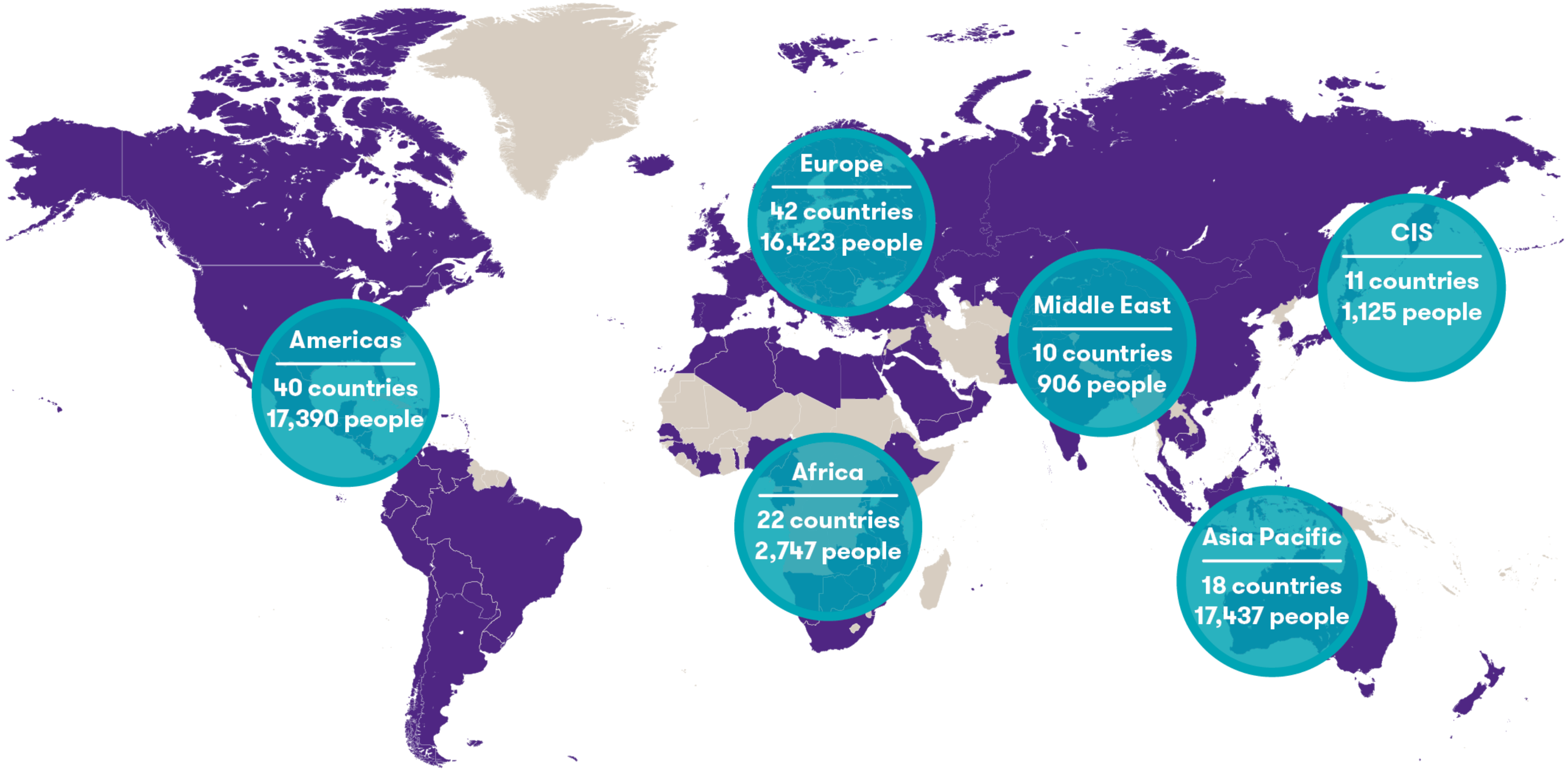
Ngongotahā	5	Waste Management Rotorua Recycle & Transfer Station	239.324885	2201
Normanby	1	Egmont Refuse & Recycling	55.240124	448
Ōakura-whangaruru South	1	Hikurangi Transfer Station	44.879882	326
Ohai	1	Invercargill Transfer Station	29.262373	362
Ohakune	4	Ohakune Recycling Centre and Secondhand Store	258.682464	1735
Ōhaupō	1	Cambridge Recycling Centre	28.40488	295
Ohawe	1	Egmont Refuse & Recycling	14.549854	118
Ohiwa	1	Whakatāne Transfer and Recycling Centre	18.130544	145
Ōhura	1	Waitomo District Landfill	38.914192	261
Okato	1	Envirowaste New Plymouth Transfer Station	36.453737	332
Okere Falls	1	Waste Management Rotorua Recycle & Transfer Station	28.271	260
Ōkiwi Bay	1	Picton Refuse Transfer Station	22.479652	189
Omaha	3	Mahurangi Wastebusters, Community Recycling Centre	219.037621	1470
Omakau	1	Parkburn Quarry	32.939384	280
Ōmiha	1	Waiheke Community Resource Recovery Park	62.731183	421
Omori	2	Taupō Landfill & Transfer Station	91.359723	739
One Tree Point	4	Uretiti Recycling Centre	212.009259	1540
Onemana	1	Waihi Transfer Station	55.710779	375
Ongare Point-Kauri Point	1	Waihi Transfer Station	13.615264	173
Opononi	1	East West Waste	34.085759	253
Opua	2	Northland Waste	88.649919	658
Opunake	1	Egmont Refuse & Recycling	109.370513	887
Oruatua-te Rangiita-Waitetoko	1	Taupō Landfill & Transfer Station	45.24717	366
Otakou-harington Point	2	Waste Management Dunedin Transfer Station	24.392856	259
Ōtāne	1	Waipukurau Transfer Station	36.98005	338
Owaka	1	Southern Recycling Ltd	17.940562	194
Oxford	3	Oxford Transfer Station	127.104698	1268
Paengaroa	1	Te Maunga Transfer Station	25.971312	330
Paerata	1	Pukekohe Transfer Station	71.671494	481
Pahiatua	3	Envirowaste Palmerston North transfer Station	138.268824	1369
Paparoa	1	Hakaru Re:Sort	17.871445	212
Pāremoremo	1	North Shore Refuse Transfer Station	27.118944	182
Pareora	1	Southern Recycle	20.522727	222

Parua Bay	2	Whangarei Re:Sort	36.895118	268
Pataua	1	On The Road Recycling	29.874032	217
Patumāhoe	2	Pukekohe Transfer Station	76.290654	512
Patutahi	1	Gisborne Recycle & Refuse Transfer Station	16.595035	130
Piha	2	Waitākere Refuse and Recycling Transfer Station	127.399433	855
Piopio	1	Waitomo district landfill	32.714908	262
Pirongia	1	Hamilton Transfer Station	51.706511	537
Pleasant Point	2	Southern Recycle	65.635747	710
Pōhara	1	Tākaka Resource Recovery Centre	50.720748	468
Point Wells	1	Mahurangi Wastebusters, Community Recycling Centre	58.112022	390
Pokeno	5	Pukekohe Transfer Station	246.790439	2052
Port Waikato	1	Waiuku Zero Waste	58.089562	483
Puhoi	1	Econowaste Transfer Station & Resource Recovery Centre	22.499783	151
Pukenui	1	Kaitaia Recycle Station	53.890528	400
Raetihi	2	Ohakune Recycling Centre and Secondhand Store	99.745573	669
Rakaia	2	Ashburton Resource Recovery Park	96.150672	767
Rangataua	1	Ohakune Recycling Centre and Secondhand Store	35.783165	240
Rangitāne	1	Northland Waste	24.116011	179
Rārangi	1	Picton Refuse Transfer Station	34.849407	293
Rātana	1	Midtown Transfer Station & Recycling Depot	10.223166	107
Raurimu	1	Ohakune Recycling Centre and Secondhand Store	17.891583	120
Riversdale	1	Gore Transfer Station	26.352303	326
Riverton	1	Invercargill Transfer Station	140.08755	1733
Rotoiti	1	Waste Management Rotorua Recycle & Transfer Station	42.841438	394
Rotomā	1	Waste Management Rotorua Recycle & Transfer Station	24.139084	222
Ruakākā	4	Uretiti Recycling Centre	208.429882	1514
Ruawai	1	Dargaville Recycling	21.496314	255
Russell	2	Northland Waste	99.96693	742
Sanson	1	Envirowaste Palmerston North Transfer Station	32.893245	310
Scotts Landing-Mahurangi East	1	Mahurangi Wastebusters, Community Recycling Centre	36.655275	246
Seddon	1	Blenheim Waste Sorting Centre	36.871386	310
Shelly Beach	1	Green Gorilla Riverhead	21.903762	147

Southbridge	1	Pines Resource Recovery Centre	50.852927	485
Spencerville	1	EcoDrop Styx Mill	22.129156	213
Spring Creek	1	Blenheim Waste Sorting Centre	25.69103	216
Springfield	1	Oxford Transfer Station	21.075131	201
Springston	1	Pines Resource Recovery Centre	21.075131	201
Stirling	1	Southern Recycling Ltd	12.85432	139
Tai Tapu	1	EcoDrop Parkhouse	28.414728	271
Takamatua	1	Little River Recycling Depot	23.168084	223
Takapau	1	Waipukurau Transfer Station	31.947262	292
Taneatua	1	Whakatāne Transfer and Recycling Centre	38.222497	321
Tanners Point	1	Waihi Transfer Station	9.916319	126
Tapanui	2	Gore Transfer Station	48.088105	520
Tapawera	1	Moteuka Resource Recovery	18.857714	174
Tapu	1	Thames Refuse Transfer Station	45.608558	307
Tasman	1	Moteuka Resource Recovery	29.26197	270
Te Anau	5	SDS Recycling Depot	189.235403	2341
Te Kuiti	5	Waitomo District Landfill	255.475962	2046
Te Teko	1	Whakatāne Transfer and Recycling Centre	19.289858	162
Tekapo	2	Geraldine Transfer Station	78.279379	768
Temuka	5	Southern Recycle	216.228187	2339
Thornton Bay-Ngarimu Bay	1	Thames Refuse Transfer Station	36.694833	247
Tikitere	1	Waste Management Rotorua Recycle & Transfer Station	29.249611	269
Tirau	1	Cambridge Recycling Centre	38.193108	489
Tokomaru	1	Envirowaste Palmerston North Transfer station	27.210708	279
Tokomaru Bay	1	Gisborne Recycle & Refuse Transfer Station	39.06216	306
Urenui	1	Envirowaste New Plymouth Transfer Station	44.908369	409
Waihou	1	Waihi Transfer Station	15.971012	154
Waikaia	1	Gore Transfer Station	21.502186	266
Waikari	1	Amberley Transfer Station	19.326093	182
Waikino	1	Waihi Transfer Station	17.218265	181
Waipu	2	Uretiti Recycling Centre	93.47681	679
Wairakei Village	1	Taupō Landfill & Transfer Station	19.409305	157
Wairau Valley	1	Blenheim Waste Sorting Centre	12.845515	108

Waitarere Beach	2	Ōtaki Refuse Transfer Station	90.409771	927
Waitoa	1	Waihi Transfer Station	13.1709	127
Whangapoua	1	Coromandel Town Refuse Transfer Station	58.087772	391
Whirinaki	2	Redclyffe Transfer Station	24.119979	200
Whiritoa	2	Waihi Transfer Station	51.845053	545

About the team



Our distinctive client experience sets us apart

USD5.72bn (2019 revenue)

56,028 people

756 offices

143 countries

Michael Worth

Partner

Michael.Worth@nz,gt.com

Michael has a degree in biotechnology. He leads the part of the practiced focused on driving value from strategic procurement and vendor partnerships, improving supply chains, driving waste out of processes and using intelligent automation as part of operating model transformation.

He also leads our Environment & Sustainability practice and is our internal lead for Environment and CSR.

Ken Gibb

Partner

Ken.Gibb@nz,gt.com

Ken provides process improvement, risk management, financial modelling, internal audit, and advisory services within the private commercial and public sectors. Ken has extensive commercial experience modelling uncertainty in markets. He is actively engaged in waste management through a private organisation looking at options to improve waste usage. He is experienced in dealing with boards and senior management teams through the provision of governance initiatives to improve compliance and financial reporting.

Elisha Nuttall

Senior Manager

Elisha.Nuttall@nz,gt.com

Elisha has studied Business Sustainability Management with University of Cambridge where his final assignment was in the glass sector. He has a degree in Economics & Finance. He has undertaken several projects in the glass industry, focusing on improving reporting accuracy and understanding of outcomes. He is currently implementing a Product Stewardship scheme at a private organisation. Elisha advises many of the largest Government agencies of Social and Sustainability initiatives and is also an experienced cost benefit modeler.

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