Kingborough

Kerbside General Waste and Recycling Bin Audit

March-April 2020

justWASTE CONSULTING

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SUMMARY

Kingborough Council (KC) engaged JustWaste Consulting to conduct a kerbside waste and recycling bin audit designed to achieve the following goals:

- Document the generation and contamination of household general waste and recycling
- Quantify and characterise contaminates in the two waste streams and make recommendations on their recovery or diversion to a more appropriate stream
- Conduct a CDS count in each waste stream based on eligible items from the NSW Return and Earn Scheme in prepartation for the porposed Tasmanian Government Scheme
- Develop targeted practical changes and education strategies to reduce waste contamination in all waste streams
- Document the potential diversion of materials into a future Food Organics Garden POrganics (FOGO) kerbside service.

The audit included 221 recycling and 221 general waste bins. KC initiated a stratified sampling method by JustWaste with areas and number of bins for collection to corresponds with the logistics of collection times and days. Auditing staff selected bins from the street randomly, ensuring samples from both sides of the street and skipping, at a minimum, every second house.

The bins were sorted individually to provide an opportunity to analyse variance in composition and contamination. All material was sorted into 51 different groups and categorised to correspond with the accepted material in the kerbside bins.

Key results:

General waste accounted for 52% of the total waste audited while recycling accounted for 48% (Table 4).

The general waste was composed of 11% materials eligible for the kerbside recycling collection however, a further 13% would be eligible for the planned Green Organics Collection Service and another 59% could be diverted to various council/community recycling schemes (Figure 1).

With 100% compliance to kerbside recycling services, green organics collections and the various council/community alternative recycling schemes, general waste could be reduced by 83% from an average of 8 kg per household per week to 1.3 kg per household per week.

Single-unit dwellings (SUD's) had a higher proportion of recycling in their general waste however multi-unit dwellings (MUD's) had a much higher proportion of garden organics in their general waste (Figure 4 & Table 7).

Organic material such as kitchen organics, soiled paper and cardboard and garden organics (72%) made up most potentially divertible materials, by weight, within the general waste, followed by plastic bags at 25.1% by volume.

Disposable nappies were the most common landfill item in general waste at 7.4% by weight.

Hazardous materials accounted for only 1.2% of all waste disposed to both streams with e-waste and electrical the most common material.

The recycling stream had an overall contamination rate of approximately 9% by weight and volume with approximately 27% of that contamination considered general waste and the balance consisting of either green organics or other divertible compostable and recyclables materials such as those listed in Table 6.

Kitchen organics and garden organics were the most common contamination in the recycling stream at 21% and 16% respectively.

Plastic bags were the most common contaminant in the recycling stream when analysed by volume at 51.1% but only made up 10% of the contamination by weight.

The most common landfill material disposed of to the recycling stream was disposable nappies at 8% followed by non-recyclable plastic at 6% by weight.

CDS eligible drink containers made up 20% of the total recycling and 1% of the general waste by weight.

Aluminum (48%), glass (31%) and PET (19%) containers were the most common CDS eligible materials.

Almost all aluminum in the recycling stream was eligible for the CDS.

Just over one third of glass and PET disposed of to the recycling stream is eligible for the CDS.

Overall, 88% (by weight) of all recyclable materials has been diverted to the recycling stream from the general waste.

Glass has the highest diversion rate (93%) while liquid paper board has the lowest diversion rate (36%).

Key Recommendations:

- Include MUDs with more than 3 units in the Green Organics Collection on an 'opt-in' basis
- Consider a full FOGO collection service
- Information to MUDs on creative and space savings ways to separate recycling and organics in small spaces and how to set up shared storage spaces for storing recyclable items for later drop-off to recycling facilities and drop-off locations
- Clarify which items are accepted in the kerbside recycling scheme while promoting the location of alternative recycling schemes for things like plastic bags and e-waste
- Rebuild community confidence in recycling
- Promote the CDS (once implemented)
- Continue to conduct kerbside waste audits after the introduction of the Green Organics Collection Service.

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1. INTRODUCTION

JustWaste Consulting was engaged by Kingborough Council (KC) to conduct a kerbside waste audit designed to identify the contamination in both the general waste and recycling streams, to make recommendations on the possible diversion of contamination to the appropriate waste streams and to provide information on the number and type of containers eligible for the proposed Container Deposit Scheme (CDS).

The goal of the audit was to measure household waste generation, the composition of different streams and to monitor performance of systems through analysis of recovery and contamination rates.

Specifically, the aim was to:

- Document the generation and contamination of household general waste and recycling
- Quantify and characterise contaminates in the two waste streams and make recommendations on their recovery or diversion to a more appropriate stream
- Conduct a CDS count in each waste stream based on eligible items from the NSW Return and Earn Scheme in prepartation for the porposed Tasmanian Government Scheme
- Develop targeted practical changes and education strategies to reduce waste contamination in all waste streams
- Document the potential diversion of materials into a future Food Organics Garden POrganics (FOGO) kerbside service.

Picture 1 JustWaste staff 'bag and tag' kerbside general waste and recycling in the 2020 kerbside waste and recycling bin audit.

2. METHODOLOGY

2.1. Sample selection

This *2020 Kerbside Waste and Recycling Bin Audit* has been designed to conform to the *Guidelines for Conducting Household Kerbside Residual Waste, Recycling and Garden Organics Audits in NSW Local Government Areas* (DECC, 2008) and *Addendum* (DECCW, 2010) in the absence of Tasmanian auditing guidelines.

The audit was conducted over 5 days between Friday the 27th March and Tuesday the 7th of April 2020. Samples were taken from coastal areas within the Kingborough Council area (Table 1). The Guidelines stipulate the auditing of 220 bins from both general waste and recycling. KC initiated a stratified sampling method by JustWaste with areas and number of bins for collection to corresponds with the logistics of collection times and days. Auditing staff selected bins from the street randomly, ensuring samples from both sides of the street and skipping, at a minimum, every second house.

Table 1 Audit date, area and number of bins collected per waste stream for the 2020 kerbside waste and recycling bin audit.

			Number of Bins	
Day	Date	Area	General Waste	Recycling
Friday	27/03/2020	Margate	44	44
Friday	27/03/2020	Snug	44	44
Thursday	2/04/2020	Taroona	44	44
Monday	6/04/2020	Blackmans Bay	21	21
Monday	6/04/2020	Kingston Beach	23	23
Tuesday	7/04/2020	Kingston	45	45
		Total	**221**	**221**

A general ratio of 7:1 single unit dwellings (SUD's) to multi-unit dwellings (MUD's) was maintained throughout the audit process although this ratio was higher in Snug, Margate, Blackmans Bay and Kingston and lower in Taroona and Kingston Beach (Table 2).

Table 2 Breakdown of the number of single-unit (SUD) and multi-unit (MUD) dwellings audited in the 2020 kerbside waste audit.

	MUD		SUD	
	Dwellings	%	Dwellings	%
Snug	7	16	37	84
Margate	6	14	38	86
Taroona	0	0	44	100
Blackmans Bay	4	20	17	80
Kingston Beach	1	4	22	96
Kingston	9	20	36	80
Total	**27**	**12**	**194**	**88**

2.2. Collection procedures

A total of 442 general waste and recycling bins were sampled over a three-week period for this bin-by-bin audit. During this time, JustWaste staff drove around in the early morning of each day to collect samples before the trucks came through (Picture 1 & Picture 2). On the street each bin was 'bagged and tagged'. In effect the content of each bin was emptied into a plastic bag, tagged with the street

address, date of collection and fullness, and placed in a truck. All samples were collected from paired households where both the general waste and recycling bins were presented for collection.

Picture 2 JustWaste staff collecting general waste and recycling during the 2020 kerbside waste and recycling bin audit.

2.3. Sorting procedures

Once the allocated number of samples for the day had been collected, JustWaste staff took the bags to the Barretta Transfer Station where they were unloaded onto the concrete floor. Each bag was placed upon a table where it was carefully cut open with a knife. Auditors sorted all the material into different tubs that were weighed on a digital scale (Picture 3). The scale was recalibrated regularly throughout the day.

Picture 3 The sorting process at the Barretta Transfer Station.

2.4. Classification of material

The material types used in this audit generally adhere to those provided in Attachment 6 of the *Guidelines for Conducting Household Kerbside Residual Waste, Recycling and Garden Organics Audits in NSW Local Government Areas (DECC, 2008).* In some instances, a new category was created by auditing staff to better represent the waste encountered. These new categories were labelled 'other' (Table 3).

This audit report presents some material in different categories than specified in the Guidelines data sheet template. These categories were decided based on accepted waste in existing kerbside services in discussion with KC. Specifically, textiles, animal waste and treated timber were categorised as general waste rather than FOGO. Disposable nappies were categorised as general waste rather than paper. Soiled paper & cardboard were categorised as general waste rather than paper.

Table 3 List of material types measured in the 2020 kerbside waste and recycling bin audit with their corresponding category and appropriate bin.

Bin	Category	AWD	Material
Recycling	Paper & cardboard	A01	Paper and Newsprint
		A04	Cardboard
		A06	Liquid Paper Board - no foil
		A06	Liquid Paper Board - CDS
		A06	Liquid Paper Board - FOIL
	Accepted recyclable plastics	E01	PET 1
		E01	HDPE 2
		E02	PET - CDS
		E02	HDPE 2 - CDS
		E03	PVC 3
		E04	LDPE 4
		E05	Polypropylene 5
		E07	Other Plastic 7
	Metals	F01	Steel Containers
		F01	Steel Containers - CDS
		F011	Aerosols
		G01	Aluminium Containers
		G01	Aluminium Containers - CDS
	Glass	D012	Glass Containers
		D012	Glass Containers - CDS
Residual	Food organics - Compostable	B01	Food Kitchen
	Garden organics - Recyclable at Barretta	B02	Garden Organics
	Other organics - Untreated Timber is recyclable at Barretta	C01	Untreated Timber
		A092	Soiled Paper and Cardboard (pizza/serviettes)
		I03	Ash
		Other	Compostable Packaging
		Other	Hair
	HAZARDOUS MATERIALS - E-waste, paint and batteries can be dropped off at Barretta for recycling	H01	Paint
		H03	Batteries Household
		H04	Batteries Car
		Other	E-waste and Electrical
		H02	Fluro Tubes
		H05	Chemicals
		H07	Clinical/Pathogenic/Infectious
	Potentially recyclable. - Textiles through charity shop, plastic bags through REDcycle bins at Woolworths and Coles, X-Rays at Kingborough Civic or Sports Centre, steel at Barretta (fees apply)	C02	Textiles
		E072	Plastic Bags
		Other	X-Ray
		F01	Steel Other
	Currently landfilled	A09	Composite (mostly paper) coffee cups
		A90	Disposable Nappies
		B03	Animal Waste (Poo)
		C04	Rubber
		E06	Polystyrene 6
		E06	Expanded Polystyrene
		E071	Foam
		E08	Composite Plastic Metal Non-Recyclable
		I01	Ceramic/Non-Recyclable Glass
		I02	Soil/Dirt/Rock
		I50	Building Materials
		Other	Treated Timber
		Other	Non-Recyclable Plastic

2.5. Waste analysis

All household bin data was entered separately in MS Excel. All samples were collected and analysed in 'paired properties' allowing the quantification and characterisation of contaminates in the two waste streams as well as their current diversion rates.

Analysis looked at total compositions, breakdown of categories, standard deviations and bin fullness and weight spread. An analysis on dwelling style, hazardous waste and the CDS was also completed.

2.6. Workplace health and safety

The JustWaste auditing process adheres to strict workplace health and safety requirements. Key considerations for this audit were:

- Allowing ample time to sort the waste. This prevents staff from rushing and reduces the risk of a workplace accident or injury occurring
- Employing staff who are experienced in sorting of waste and who are well trained in safety matters related to the task
- Providing appropriate Personal Protective Equipment (PPE) for sorting including gloves, safety boots and protective overalls
- Scheduling breaks and providing staff with cold drinking water and snacks
- Ensuring JustWaste staff are up to date with the relevant immunisation schedules
- Providing a suitable space for the sorting procedure to take place. The designated area is accessible by car and trailer for the delivery of audit materials, undercover with a concrete floor, and is open and well ventilated
- Ensuring an adequate means of disposal for the audited materials.

3. RESULTS

3.1. Overall Composition of Two Waste Streams

A total of 3,382 kg of waste was audited over two waste streams with 52% (by weight) disposed of in the general waste bins and 48% (by weight) in the recycling bins (Table 4). In total, 51% of the total waste audited was considered general waste while 49% of audited waste was classified as recycling.

Table 4 Composition of two waste streams in the KC 2020 kerbside waste and recycling audit.

	General Waste		Recycling		Total		% of all Waste		Average Bin Fullness	SD
	Weight (kg)	Volume (L)	Weight (kg)	Volume (L)	Weight (kg)	Volume (L)	Weight (%)	Volume (%)	(%)	(%)
General Waste Bin (Weekly)	1,570	17,385	201	3,217	1,772	20,602	52	39	86	22
Recycling Bin (Fortnightly)	139	2,850	1,471	28,855	1,610	31,705	48	61	88	20
Total	**1,710**	**20,235**	**1,672**	**32,071**	**3,382**	**52,306**	**100**	**100**		
% of all Waste	**51**	**39**	**49**	**61**						

Although the proportion of waste disposed of to the general waste and recycling was similar to the proportion of actual waste classified as general waste and recycling, only 90% of the total waste was disposed of to the correct stream (47% general waste and 43% recycling) (Table 5). This means that 10% of the total waste audited was disposed of to the incorrect stream and thus considered a contaminate. The general waste had 201 kg (or 6% of total waste) which was eligible to be diverted to the recycling stream while the recycling stream had 139 kg (or 4% of total waste) of contaminating material (Table 4 & Table 5).

Table 5 Composition of total waste audited in 2020 as a percentage of total waste collected by weight and volume.

	General Waste		Recycling		Total	
	Weight (%)	Volume (%)	Weight (%)	Volume (%)	Weight (%)	Volume (%)
General Waste Bin (Weekly)	47	33	6	6	52	39
Recycling Bin (Fortnightly)	4	6	43	55	48	61
Total	**51**	**39**	**49**	**61**	**100**	**100**

The average bin fullness was similar for both waste streams with 86% and 88% for general waste and recycling respectively (Table 4). The ratio of weight to volume for the recycling stream was lower at 0.79 compared to the general waste at 1.33 indicating that the general waste was denser, and the recycling was more voluminous.

Given the proportion of general waste to recycling is similar, despite the fact that recycling is collected less often than general waste, it can be inferred that general waste is generated at more than double the rate of recycling.

3.2. General waste bin

3.2.1. Overall composition

A total of 221 individual general waste bins were audited accounting for a total 1,772 kg of waste and an average household weight of 8 kg ± 5.6 kg. General waste collection occurs on a weekly basis, so an average 16 kg of general waste is generated per household per fortnight.

According to KC's current waste collection scheme, 11% (by weight) of the general waste was divertible to the kerbside recycling (Figure 1). A further 72% (by weight) of the general waste is potentially divertible to alternative recycling schemes. For example, 13% (by weight) of waste in the general waste stream was classified as 'garden organics' and would be eligible for the Green Organics Service to be introduced to eligible households on Monday, 6 July 2020 (Figure 1). The remaining 59% (by weight) could be diverted through various schemes as detailed in Table 6.

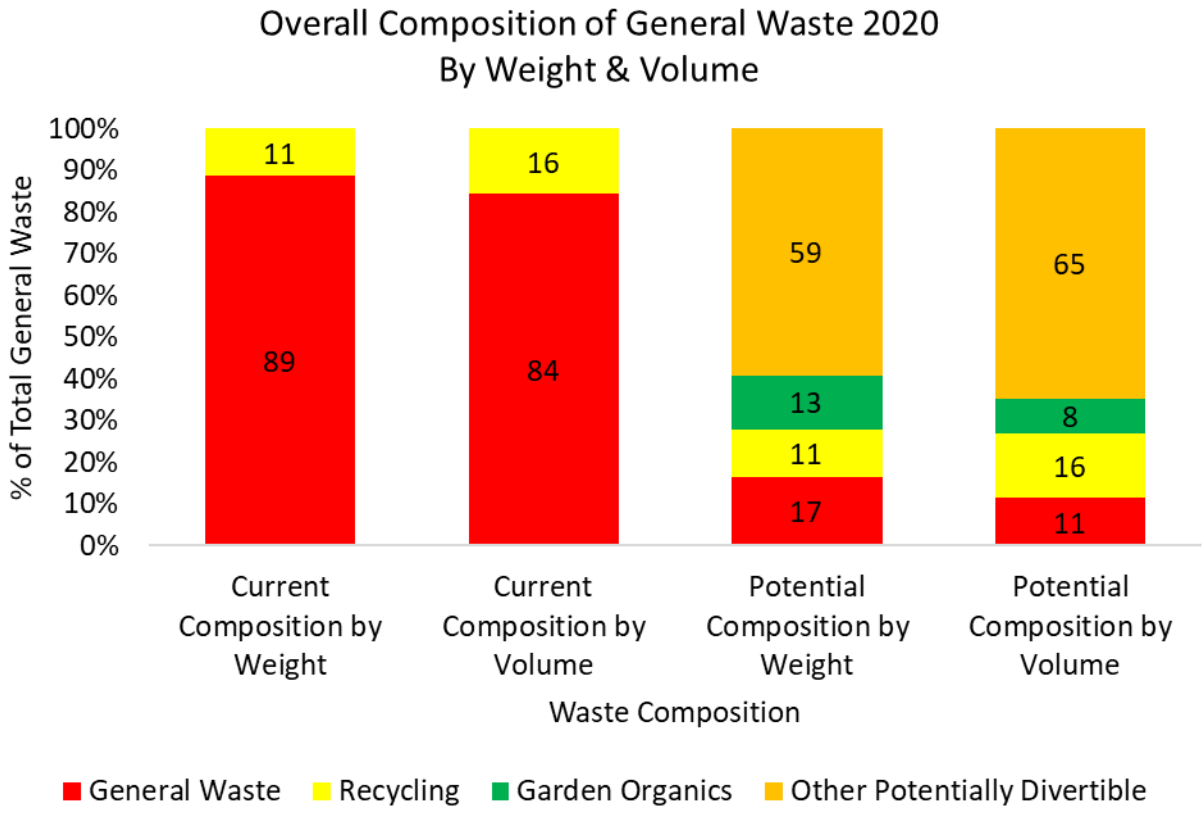


Figure 1 Overall composition, by weight and volume, of the general waste stream and composition of general waste potentially divertible to alternative recycling services for the 2020 kerbside waste and recycling bin audit.

Table 6 Breakdown of potentially recyclable material disposed of in the 2020 kerbside waste and recycling bin audit.

Material	(kg)	Diversion Opportunities
Food Kitchen	768	Potentially compostable through home composting or future FOGO service.
Soiled Paper and Cardboard (pizza/serviettes)	127	
Compostable Packaging	2	
Ash	13	
Hair	1	
Untreated Timber	5	The Barretta Waste Management Facility can accept untreated timber for a fee. Timber is chipped and sent to Brighton to be used as a fuel source within compost.
Steel Other	8	OneStop Metal Recycling (Tas) Pty Ltd accepts all ferrous and non-ferrous metals. Barretta Waste Management Facility can also accept scrap steel for a fee.
Plastic Bags	63	REDcycle drop-off point at Kingston Woolworths.
Paint	-	The Barretta Waste Management Facility can accept these items for recycling at no cost.
Batteries Car	-	
Batteries Household	-	
Computers and TV Recycling	29	
Textiles	31	Local thrift shop or Barretta Re-Use Shop can accept items in good condition, otherwise landfill.
X-Ray	0	Kingborough Civic or Sports Centre can accept these at designated times. Barretta Waste Management Facility can also accept these.
Total Weight (kg)	**1,047**	
% of Total General Waste	**59**	

Kingston Beach had the lowest level of divertible recyclable materials in their general waste bins at 4% which was 7% below the average with Kingston similarly below the average at 7% (Figure 2). Snug had the highest level of contamination at 17% which was 6% above the average (Figure 2). Blackmans Bay, Margate and Taroona all had between 2-3% above the average level of divertible recyclable materials.

When analysing the *potentially* divertible materials as listed in Table 6, Kingston Beach actually had the least at 56% (11% Garden Organics & 45% Other) while Taroona had the highest level at 78% (14% Garden Organics & 64% Other) (Figure 3).

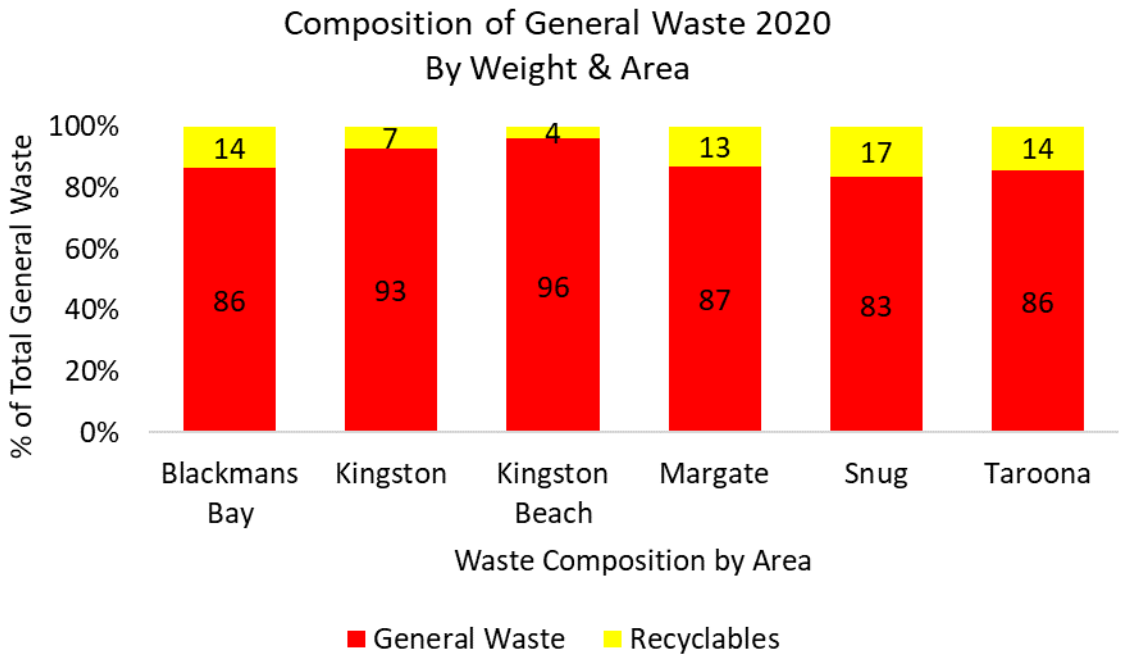


Figure 2 Composition of general waste by weight and area for the 2020 kerbside waste and recycling bin audit.

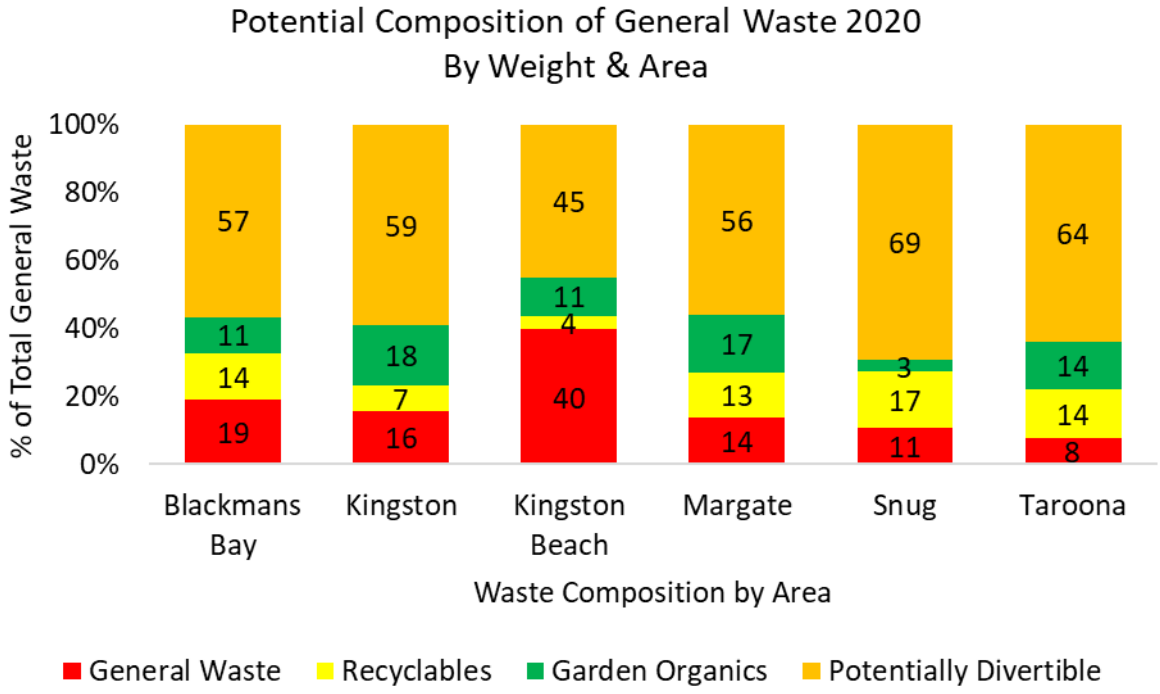


Figure 3 Potential composition of general waste by weight and area for the 2020 kerbside waste and recycling bin audit.

3.2.2. MUD'S

A total of 27 multi-unit dwelling (MUD) bins were audited (Table 7). MUDs represented 12% of the total bins sampled, and also accounted for 12% of the total general waste (Table 7). This means that MUD's and SUD's had almost identical average household bin weights at approximately 8.0 kg (Table 7). On average, MUD's had half as much divertible recyclable materials (6% compared to 12% for SUD's) and 6% less 'Other' potentially divertible materials (54% compared to 60% for SUD's), but noticeably higher levels of potentially divertible Garden Organics (33% compared to 10% for SUD's).

Table 7 Breakdown of general waste based on dwelling style for the 2020 kerbside waste and recycling bin audit.

	Number of Bins	% of Bins	General Waste (kg)	General Waste (%)	Average Bin Weight (kg)	Average Bin Weight SD (kg)	Divertible Recycling (%)	Potentially Divertible Garden Organics (%)	Potentially Divertible Other (%)
MUD	27	12	220	12	8.2	5.9	6	33	54
SUD	194	88	1,551	88	8.0	5.6	12	10	60
Total	**221**	**100**	**1,772**	**100**	**8.0**	**5.6**	**11**	**13**	**59**

Overall, MUD's had two and a half times less general waste than SUD's after divertible and potentially divertible materials were accounted for (Figure 4).

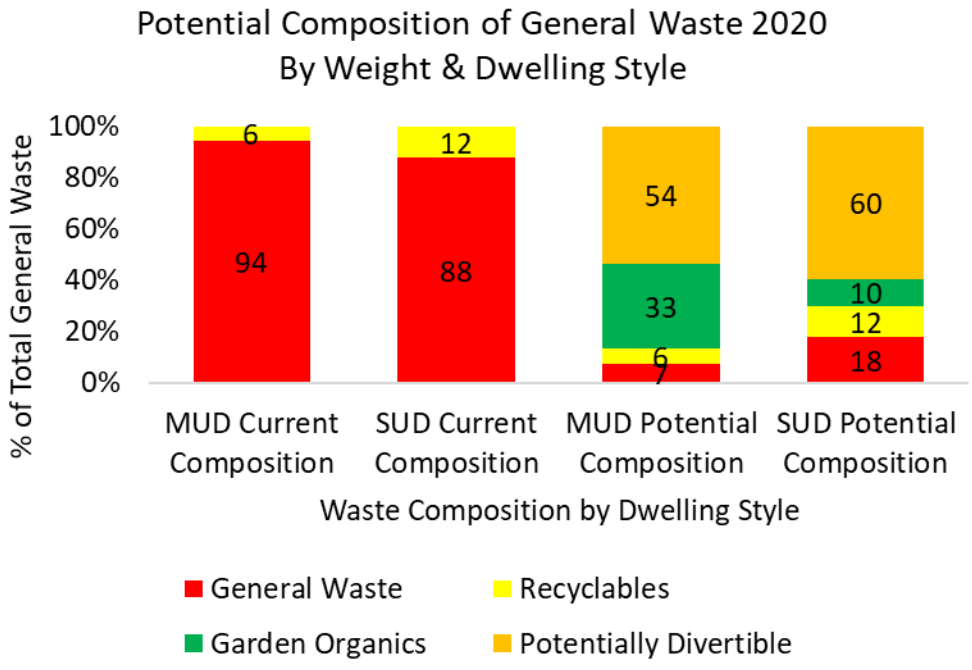


Figure 4 Breakdown of general waste and potentially divertible materials by dwelling style for the 2020 kerbside waste and recycling bin audit.

3.2.3. Household weights & bin fullness

A total of 221 individual bins were audited generating a total of 1,772 kg of waste. The average bin weight measured in the 2020 audit was 8 kg/bin/household (Table 8). The mean of 8.0 kg and median of 7.0 kg demonstrate a positive skew on the data indicating a small number of households with very heavy bins distorting the data. This is also highlighted in Figure 5 where it can be seen that 18 households (or 8%) have bin weights over 15 kg while the vast majority of households (160 or 72%) have bin weights of 10 kg or less. The heaviest bin in the dataset was 44.64 kg and was a SUD from the Kingston Beach area while the lightest bin was 0.34 kg and was a MUD from Blackmans Bay.

Table 8 General waste stream bin yield and extrapolations for the 2020 kerbside waste and recycling bin audit.

	Units	Including Outliers	Excluding Outliers
Collection Period	-	Weekly	
Average General Waste Bin Weight	kg	8.0	7.6
Standard Deviation	kg	5.6	4.5
Median General Waste Bin Weight	kg	7.0	6.9
Extrapolated Monthly Average General Waste Generation per Household	kg	34.7	29.9
Extrapolated Annual Average General Waste Generation per Household	kg	416.9	359.3
Extrapolated Annual Council General Waste Generation*	tonnes	6,607.3	5,695.2
Extrapolated Annual Average per Person General Waste Generation^	kg	184.3	158.8

*Based on 15,850 households (2016 Census)
^Based on 35,853 population (2016 Census)

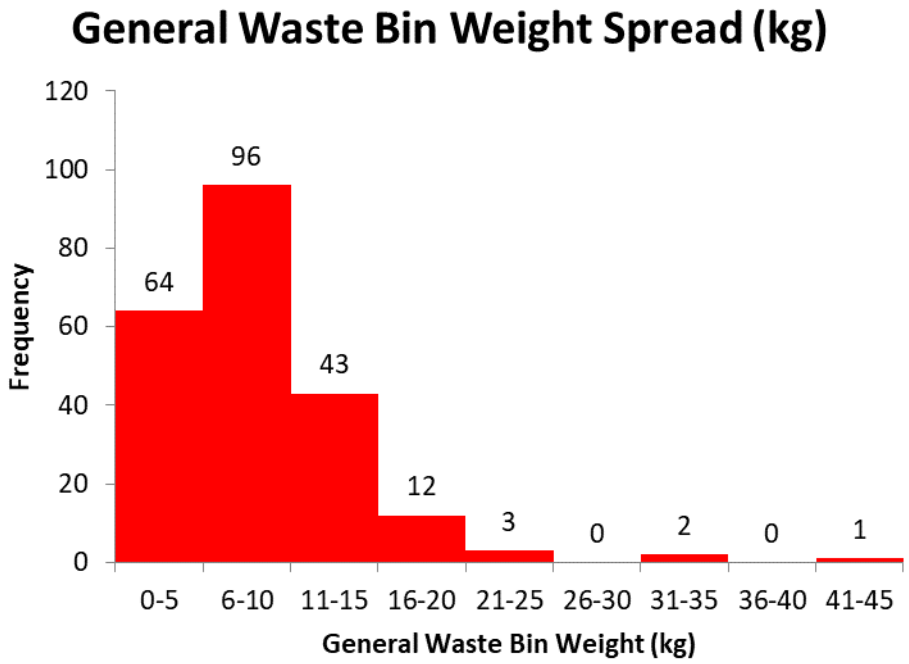


Figure 5 Frequency histogram for the general waste bin weight spread of the 2020 kerbside waste and recycling bin audit.

There were 3 households with bin weights over 28 kg (Figure 5). These households are considered to be major outliers within the data set. By removing these outliers from the data set the new average household bin weight is 7.6 ± 4.5 kg (SD) with a median weight of 6.9 kg. The new extrapolated annual average waste generated per person, using the new median weight of 6.9 kg, would thus be 158.6 kg.

The average bin fullness was 86% of capacity with 99 bins (44.8%) at full capacity and 8 bins (3.7%) overfull (Figure 6).

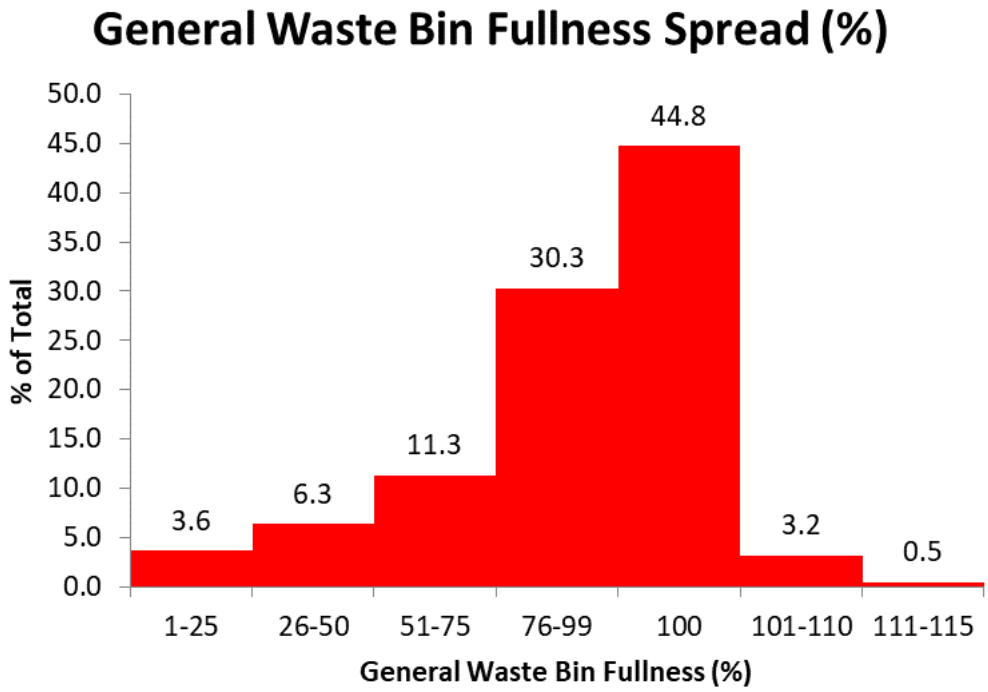


Figure 6 General waste bin fullness spread for the 2020 kerbside waste and recycling bin audit.

When analysed by area, 5.0% of Blackmans Bays bins were greater than 110% full while Margate had no overfull bins (Figure 7). Kingston Beach had the highest proportion (58.3%) of bins at 100% capacity followed by Taroona (52.3%). Interestingly, Taroona also had the largest proportion of bins under 75% full (24.9%) while Kingston Beach had the lowest proportion at 12.5% (Figure 7).

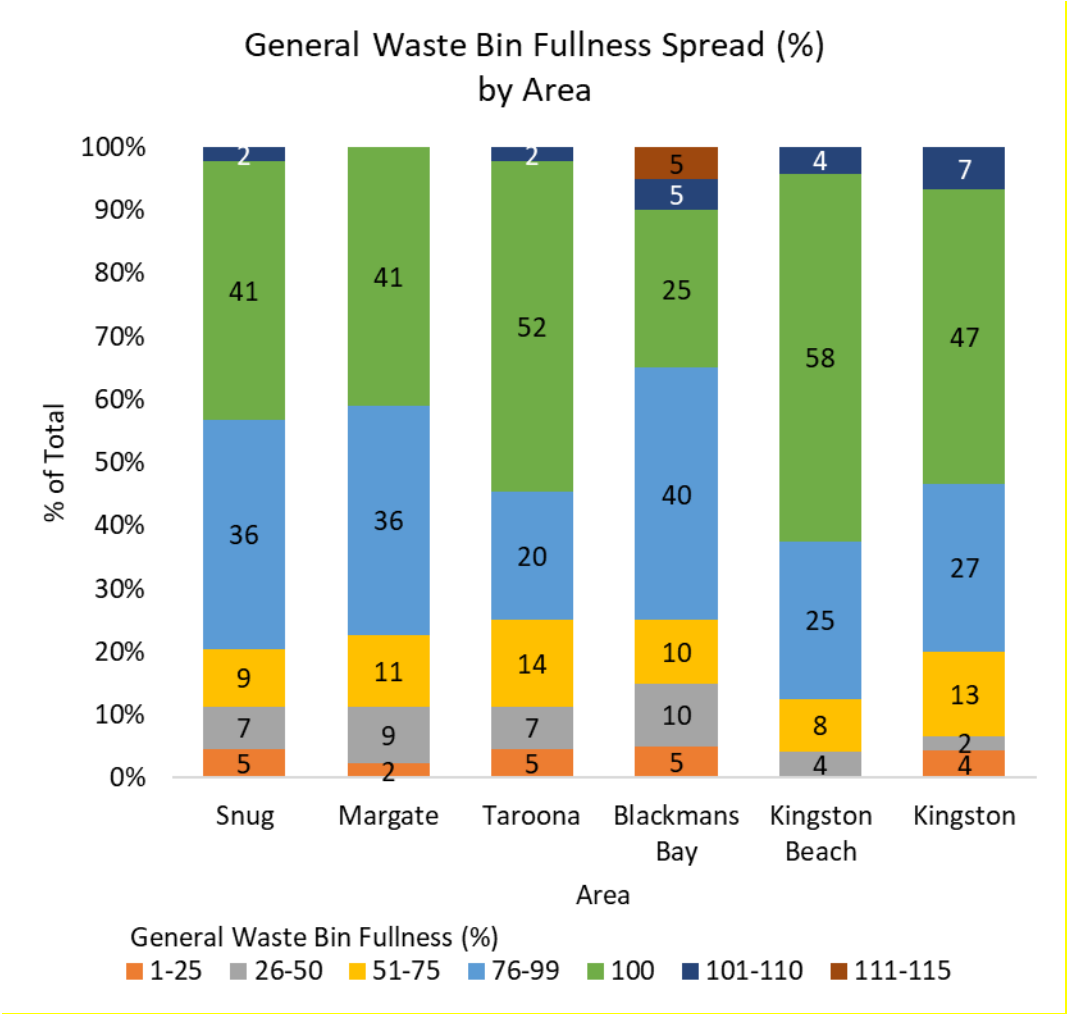


Figure 7 General waste bin fullness spread by area for the 2020 kerbside waste and recycling audit.

3.2.4. Composition of general waste in the general bin

A total 1,772 kg of waste was disposed of to the general waste bins in 2020 accounting for 52% of total waste (Table 4). Notably however, only 1,570 kg or 47% of total waste, was correctly disposed of to this waste stream (Table 5).

The composition (by weight) of the correctly disposed general waste was dominated by kitchen organics at 48.9% followed by garden organics at 14.7% (Figure 8). Organic matter that would be either compostable at home or could be diverted to either a green organics collection or possible FOGO collection made up 75.7% of the correctly disposed general waste. Another 8.4% could be potentially diverted to an alternative recycling scheme as outlined in Table 6.

The remaining 15.9% of the general waste was predominantly disposable nappies (7.4%) and animal waste (4.5%) (Figure 8).

Figure 8 demonstrates that certain items, particularly plastic bags, and expanded polystyrene, have a very low weight/volume ratio with plastic bags accounting for 25.1% of the general waste by volume but only 4.0% by weight.

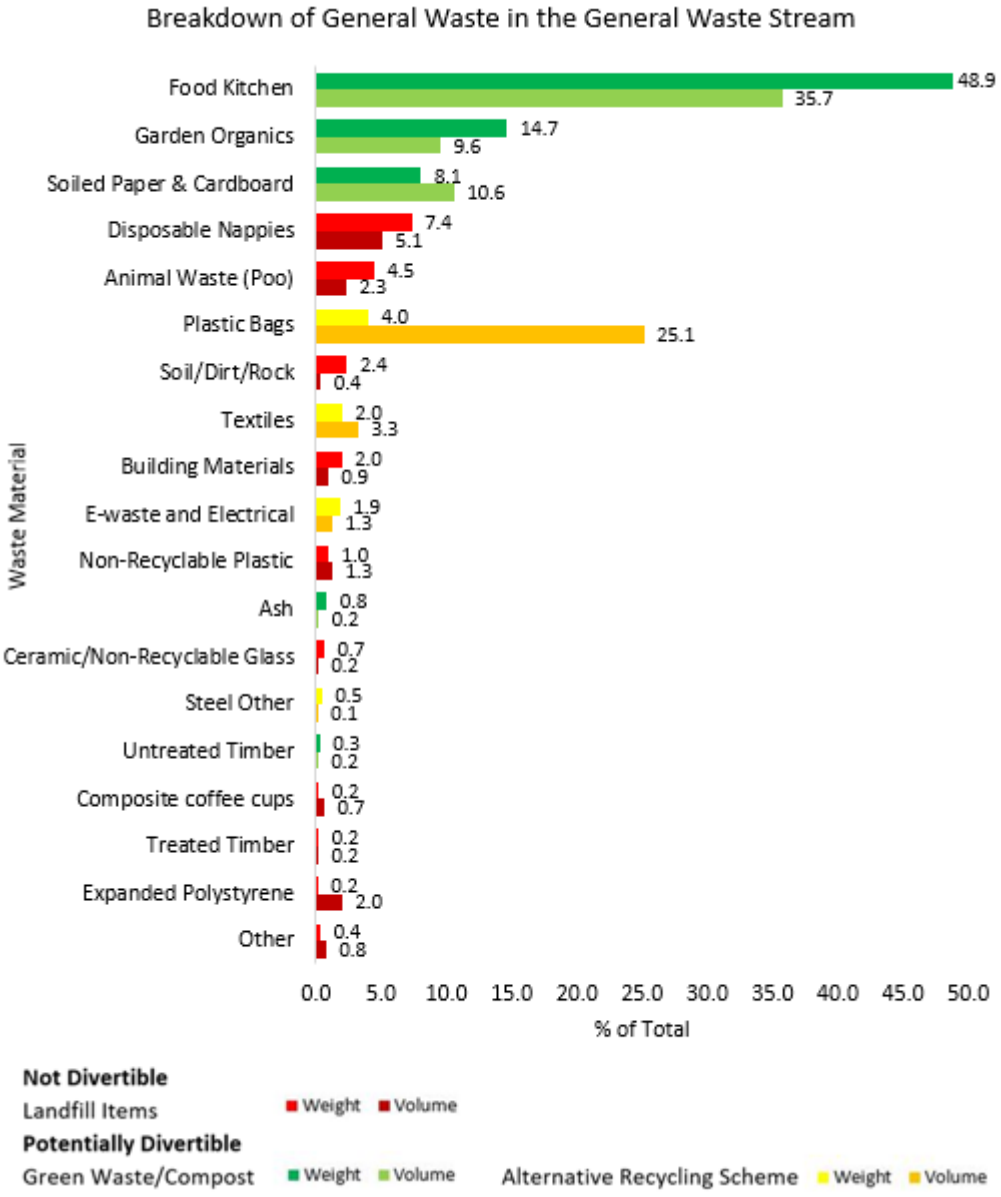


Figure 8 Breakdown of general waste in the general waste bin, by weight and volume, for the 2020 kerbside waste and recycling bin audit. Items in green are potentially divertible to garden compost, green organics collection or possible FOGO collection, items in yellow are potentially divertible to alternative recycling schemes and items in red are landfill items.

Waste classified as 'Hazardous' made up only 1.2% of total waste disposed to all streams and accounted for 34.27 kg or 1.93% of the general waste in particular (Table 9 & Picture 4). Hazardous items can carry a disproportional risk of fire and contamination of land, water, and air. 'E-waste and Electrical' was the most common hazardous waste with 21 households (9.5%) disposing of 29.42 kg of waste (Table 9).

Picture 4 Hazardous waste, including lithium cell battery, electrical waste, and paint, found in the general waste and recycling streams in the 2020 kerbside waste and recycling bin audit.

Table 9 Number of households with 'Hazardous' waste and the composition of the 'Hazardous' general waste, in the 2020 kerbside waste and recycling bin audit.

Hazardous Materials	Number of Households	% of Households	Weight (kg)	% of General Waste
E-waste and Electrical	21	9.5	29.42	1.66
Treated Timber	4	1.8	3.37	0.19
Clinical/Pathogenic/Infectious	3	1.4	1.23	0.07
Fluro Tubes	4	1.8	0.18	0.01
X-Ray	1	0.5	0.07	0.00
Total	**33**		**34.27**	**1.93**

3.2.5. Breakdown of contamination in general waste bin

Contamination in the general waste bin is defined as material that should be diverted through another, kerbside, service i.e. recycling (Picture 5).

Picture 5 Long life/UHT cartons contaminating the general waste bins during the 2020 kerbside waste and recycling bin audit.

Recyclable contamination within the general waste stream totalled 201 kg or 11% (by weight) of the total waste disposed of in the general waste bins (Figure 1).

When analysed by weight, the majority of recyclable contaminates were paper, newsprint and cardboard (30.0%), followed by glass (24.8%), plastic (21.4%), liquid paper board (16.6%), and metals (7.1%) (Figure 9).

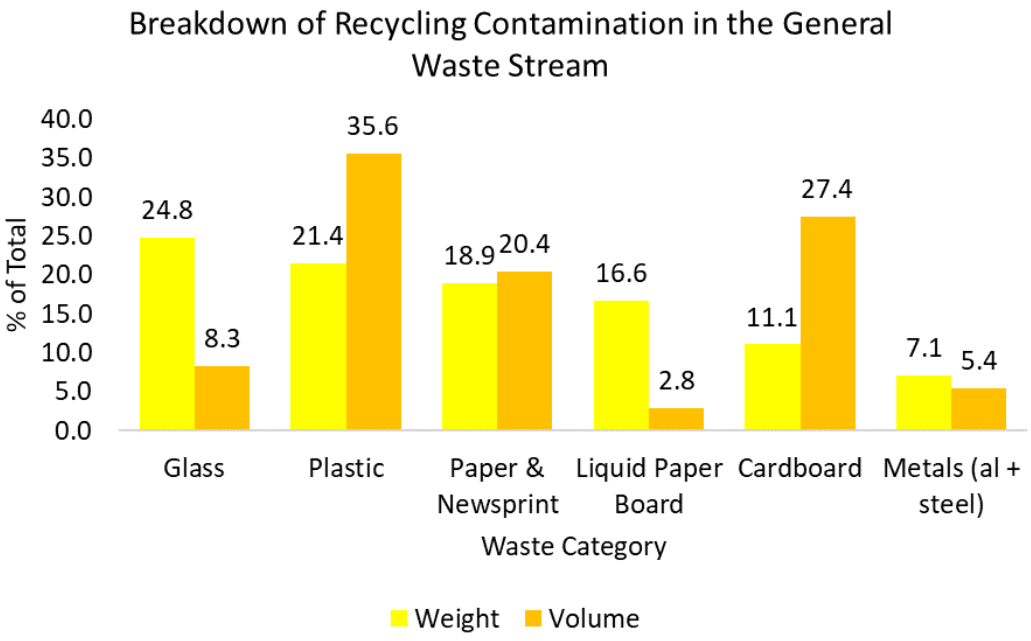


Figure 9 Composition of recyclables within the general waste stream, by weight and volume for the 2020 kerbside waste and recycling bin audit.

When analysed by volume, paper, newsprint and cardboard still made up the majority of the contamination at 47.8% however the next most prevalent contaminate was plastic at 35.6% with glass accounting for only 8.3% (Figure 9). This is explained by the higher weight/volume ratio of glass compared to plastic. Liquid paper board also has a higher weight/volume ratio while similarly to plastic, cardboard has a lower ratio. This can be seen demonstrated in Figure 9 by the discrepancies in proportion of general waste for each material by weight and volume.

3.3. Recycling bin

3.3.1. Overall composition

A total of 221 individual commingled recycling bins were audited accounting for a total of 1,610 kg of waste with an average household weight of 7.3 kg ± 4.7 kg. Commingled recycling is collected on a fortnightly basis, so an average of 3.6 kg of recycling is generated per household per week.

According to KC's current waste collection scheme, approximately 9% of the recycling stream, by both weight and volume, was considered contamination (Figure 10). Of this contamination, 1.4% (by weight) could potentially be diverted to the Green Organics Service to be introduced in KC soon, while 4.9% (by weight) could be diverted to various recycling schemes as detailed in Table 6.

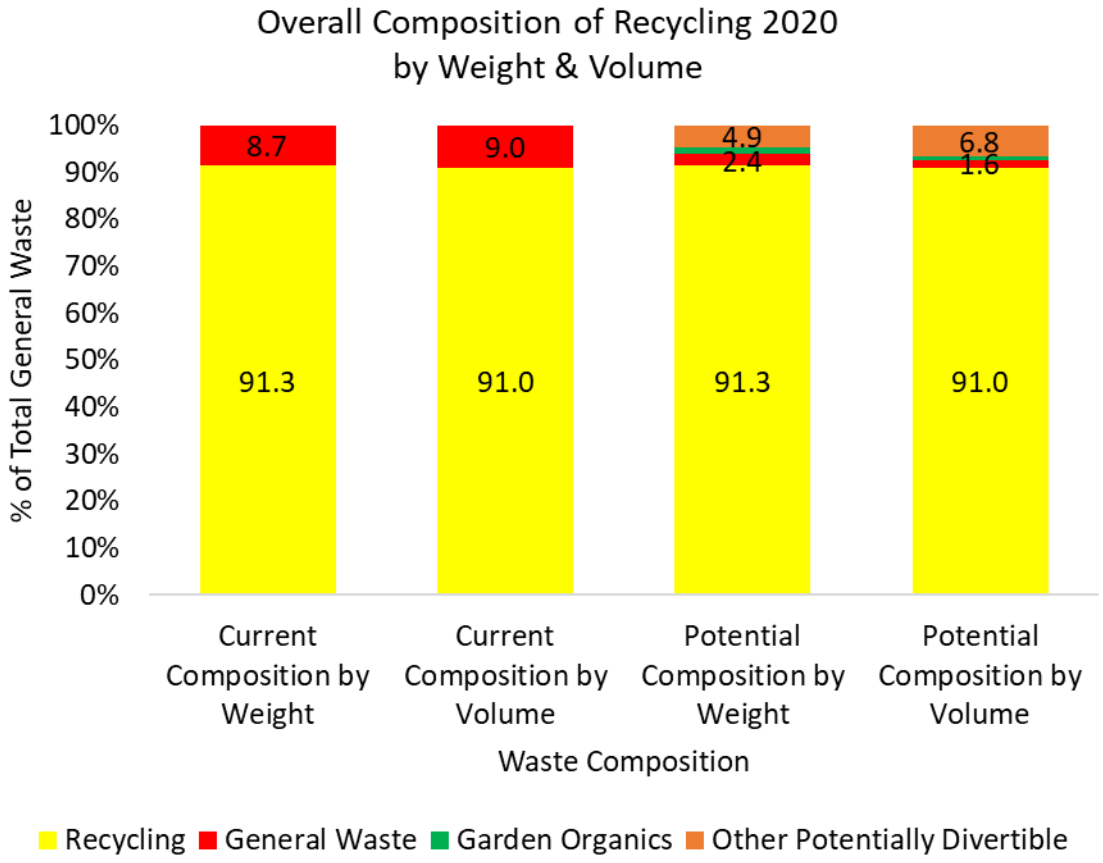


Figure 10 Overall composition, by weight and volume, of the commingled recycling stream and composition of recycling potentially divertible to alternative recycling services for the 2020 kerbside waste and recycling bin audit.

Taroona had the lowest level of contamination in the commingled recycling at 3% which was one third of the overall average of 9% (Figure 10 & Figure 11). Kingston Beach and Snug had the highest level of contamination at 13% which was almost one and a half times more than the overall average, closely followed by Margate at 12% (Figure 11).

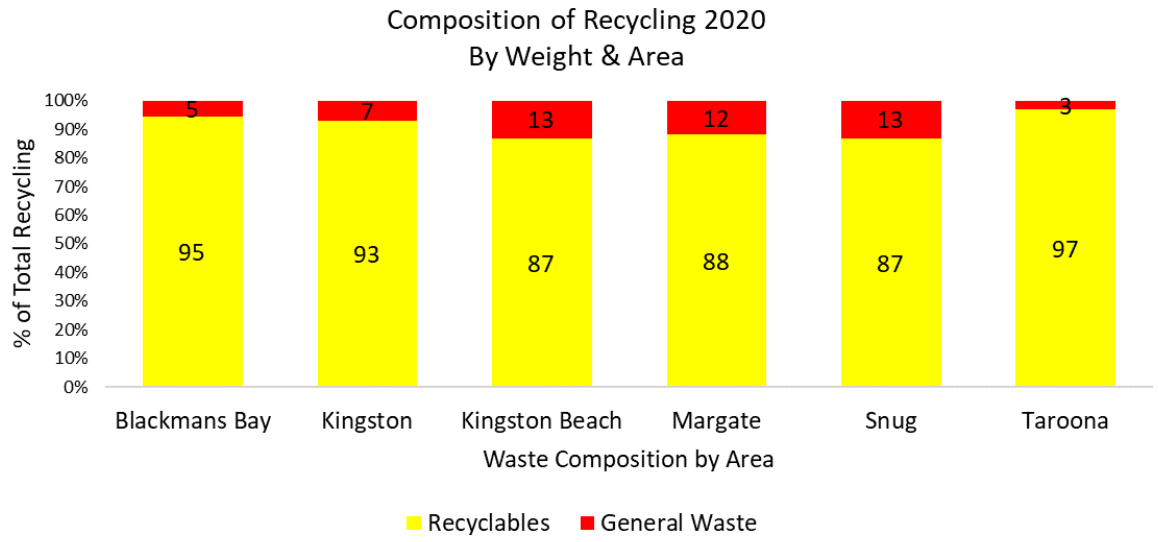


Figure 11 Composition of recycling by weight and area for the 2020 kerbside waste and recycling bin audit.

When analysing the potentially divertible materials by area, Taroona has the lowest proportion at 2.4%, leaving only 0.5% of general waste contamination (Figure 12). Blackmans Bay, also had a very small residual amount of general waste contamination (0.2%) in the recycling once the potentially divertible materials were accounted for (Figure 12). Blackmans Bay and Snug were the only areas that had any green organics contamination in the recycling at 1.2% and 7.2% of recycling respectively (Figure 12). Margate had the highest proportion of non-divertible general waste (5.8%) in their recycling followed by Kingston Beach at 4.3% (Figure 12).

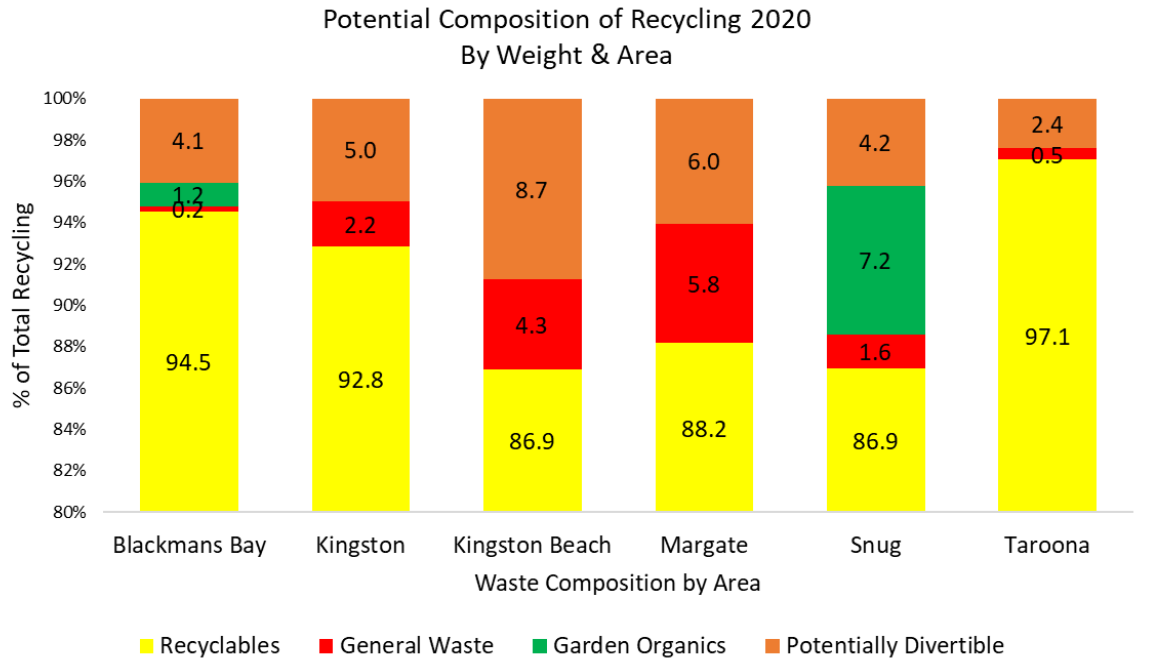


*Figure 12 Potential composition of recycling by weight and area for the 2020 kerbside waste and recycling bin audit. **N.b.** To better display the details of the contamination, the y-axis does not begin at 0.*

3.3.2. MUD's

A total of 27 MUD and 194 SUD recycling bins were audited (Table 10). MUDs represented 12% of the total bins sampled and 11% of the total recycling (Table 10). The average household bin weight for a MUD (6.3 kg ± 4.7 kg) was 15% lower than for a SUD (7.4 kg ± 4.7 kg).

There was a notable difference in the contamination rate between MUDs and SUDs with MUD's rate just over 3 times higher than SUD's (Table 10 & Figure 13). Most of the contamination in the MUD recycling bins was garden organics (11.9%) which could be diverted to the Green Organics Service while SUD's only had 0.1% garden organics contamination (Table 10). MUD's also had almost twice as much other potentially divertible materials contaminating their recycling bins (Table 10).

Table 10 Breakdown of recycling based on dwelling style, i.e. MUD or SUD, for the 2020 kerbside waste and recycling bin audit.

	Number of Bins	% of Bins	Recycling (kg)	Recycling (%)	Average Bin Weight (kg)	Average Bin Weight SD (kg)	Contamination (%)	Potentially Divertible Garden Organics (%)	Potentially Divertible Other (%)
MUD	27	12	171	11	6.3	4.7	21.6	11.9	8.5
SUD	194	88	1,440	89	7.4	4.7	7.1	0.1	4.4
Total	**221**	**100**	**1,610**	**100**	**7.3**	**4.7**	**8.7**	**1.4**	**4.9**

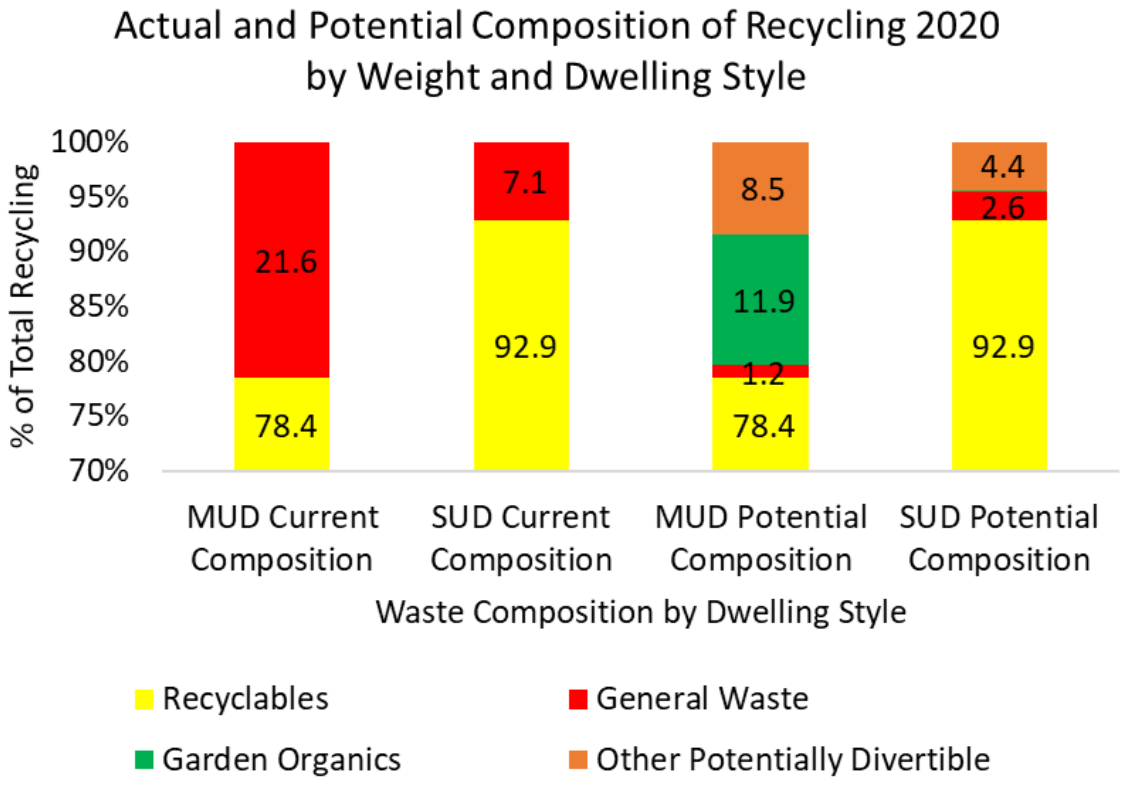


*Figure 13 Breakdown of recycling and potentially divertible materials by dwelling style for the 2020 kerbside waste and recycling bin audit. **N.b.** To better display the details of the contamination, the y-axis does not begin at 0.*

3.3.3. Household weights, bin fullness & contamination

A total of 221 individual recycling bins were audited generating a total of 1,610 kg of waste. The average bin weight measured in the 2020 audit was 7.3 kg ± 4.7 kg/bin/household (Table 11).

Table 11 Commingled recycling stream bin yield and extrapolations for the 2020 kerbside waste and recycling bin audit.

	Units	Recycling
Collection Period	-	Fortnightly
Average Recycling Bin Weight	kg	7.3
Standard Deviation	kg	4.7
Median Recycling Bin Weight	kg	6.0
Extrapolated Monthly Average Recycling Generation per Household	kg	31.6
Extrapolated Annual Average Recycling Generation per Household	kg	378.9
Extrapolated Annual Council Recycling Generation*	tonnes	6,005.9
Extrapolated Annual Average per Person Recycling Generation^	kg	167.5

*Based on 15,850 households (2016 Census)
^Based on 35,853 population (2016 Census)

The bin weight dataset for the recycling was skewed to the right with 136 household bins (62%) weighing less than the mean of 7.3 kg (Figure 14). The heaviest bin in the dataset was 24.2 kg and was a SUD in Kingston while the lightest was a MUD in Margate at 0.6 kg. Only 52 households, or 24%, had a bin weight heavier than 10 kg (Figure 14).

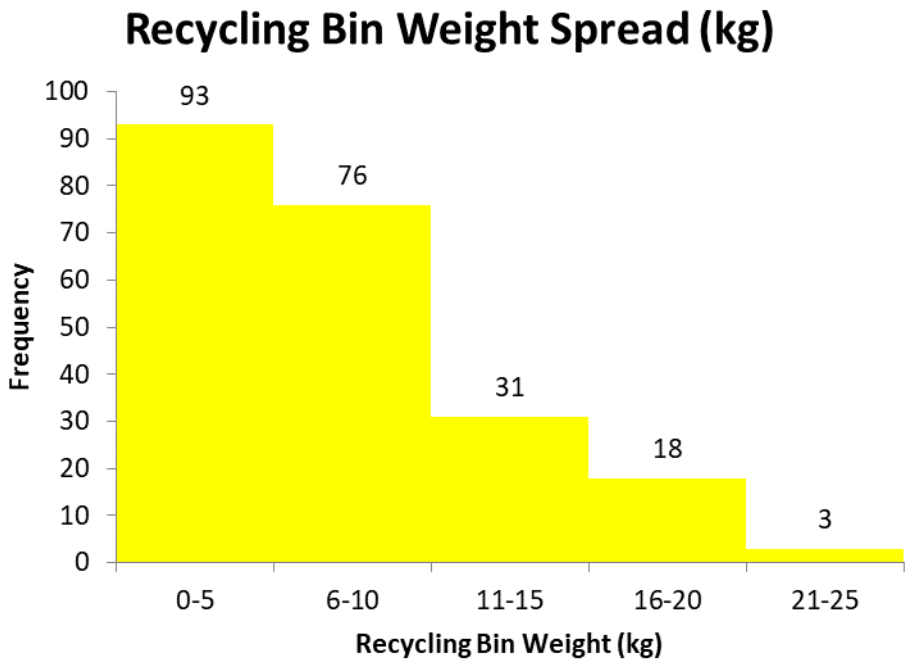


Figure 14 Frequency histogram for the recycling bin weight spread of the 2020 kerbside waste and recycling bin audit.

The average bin fullness was 88% of capacity with 97 bins (43.9%) at full capacity and 26 bins (11.8%) overfull (Figure 15). The maximum bin fullness was 115% and was a SUD in Kingston while the minimum was 5% and was a MUD in Margate.

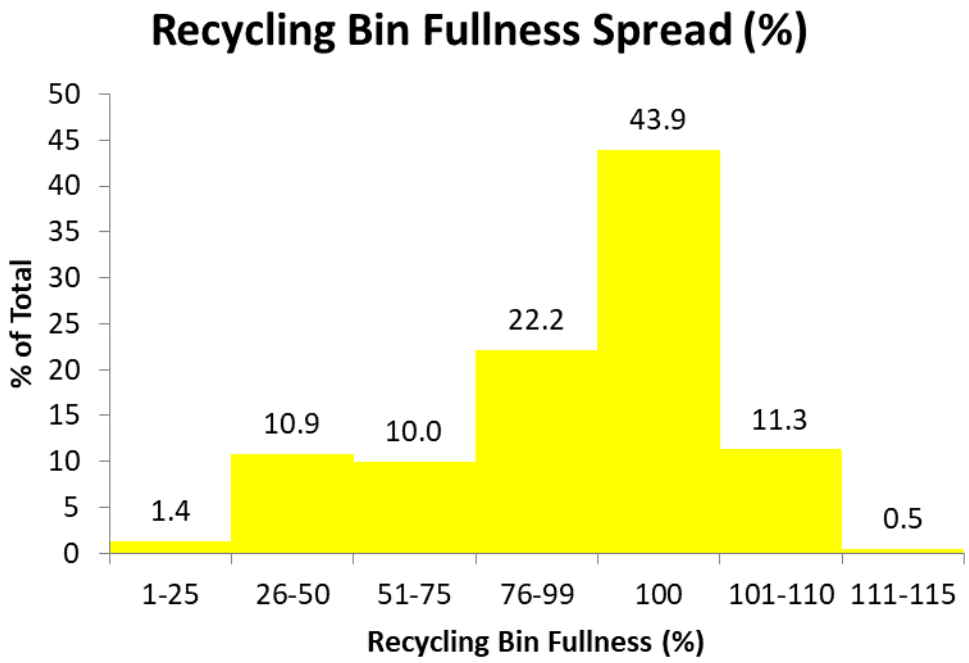


Figure 15 Recycling bin fullness (%) spread for the 2020 kerbside waste and recycling bin audit.

When analysed by area, Blackmans Bay had no overfull bins while Kingston Beach had 16.7% overfull and Taroona had 15.9% overfull (Figure 16). Kingston had 2.2% of bins greater than 110% full. Snug had the largest proportion of bins under 75% full at 56.8% while Taroona had the lowest proportion of bins under 75% full at 34.2% (Figure 16).

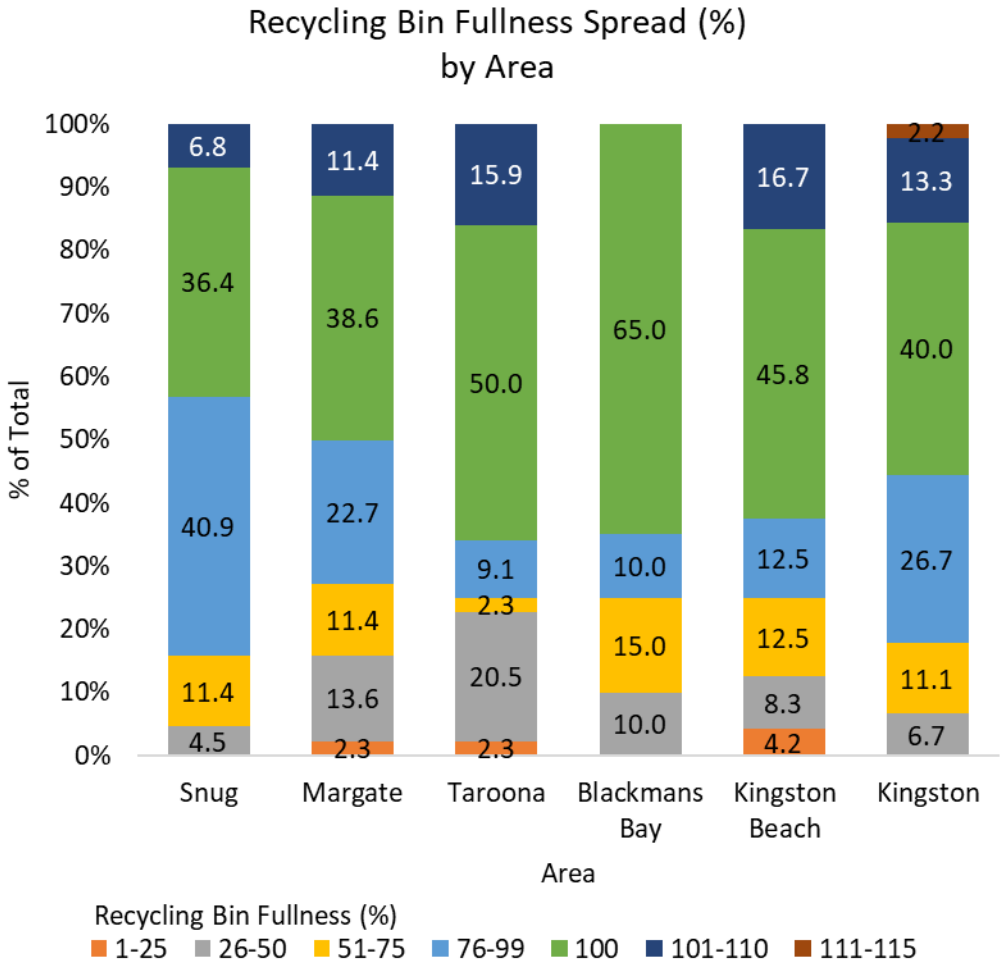


Figure 16 Recycling bin fullness spread by area for the 2020 kerbside waste and recycling bin audit.

3.3.4. Breakdown of recycling in the recycling bin

A total of 1,610 kg of material was disposed of to the recycling bins in 2020 accounting for 48% of total waste audited (Table 4). Of this, 1,471 kg (43%) was disposed of correctly with 139 kg (4%) contaminating the stream (Table 5).

The composition (by weight) of the correctly disposed recycling was dominated by glass at 46.5% and paper and cardboard at 34.8% (Figure 17). When analysed by volume, paper and cardboard made up the largest portion of the recycling at 48.3% (Figure 17). Glass, PET and HDPE made up 12.7%, 12.5% and 12.1% by volume respectively (Figure 17).

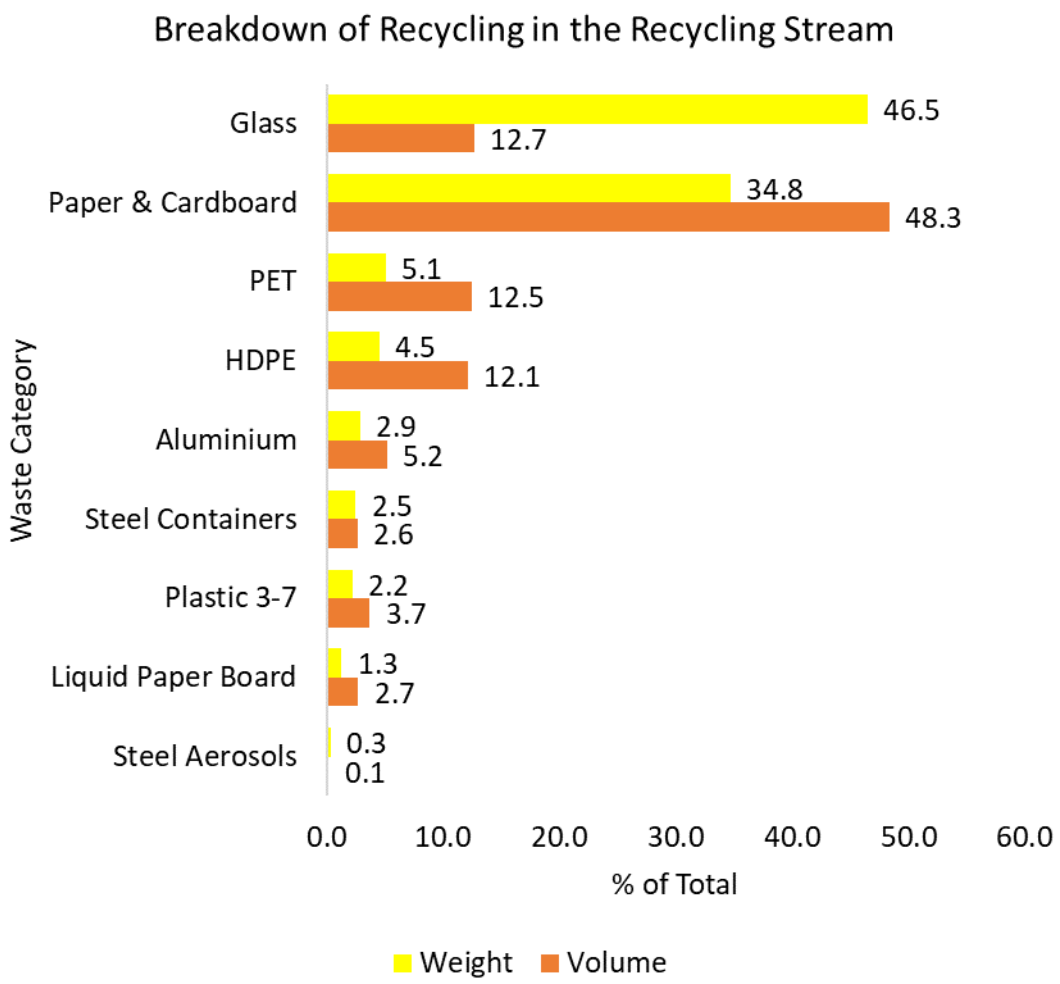


Figure 17 Breakdown of recyclable materials within the recycling bins by weight and volume for the 2020 kerbside waste and recycling bin audit.

3.4. Container Deposit Scheme (CDS)

Overall, 10% of the total waste audited (by weight), or 4,274 units, was eligible for the container deposit scheme (CDS) (Table 12). The majority of this, 3,974 units (93%) was found in the recycling stream with only 300 units (7%) disposed of to the general waste.

The CDS eligible containers disposed of in the recycling accounted for 20% (by weight) of the recycling audited or 314 kg while those found in the general waste accounted for only 1% (by weight) of the general waste stream, or 24 kg.

Despite MUD's accounting for 12% of all households audited, they disposed of a comparatively smaller proportion of the CDS eligible containers at 6.9% (6.8% Recycling & 0.1% General Waste) compared to SUD's which disposed of over 93% (86.2% Recycling & 6.9% General Waste) of the CDS eligible containers (Table 12).

Table 12 Number and type of drink containers eligible for the container deposit scheme (CDS) discarded in both the waste and recycling streams.

Waste Stream	Dwelling Style	Liquid Paper Board		PET		HDPE 2		Glass Containers		Aluminium Containers		Steel Containers		Total	
		(Units)	%	(Units)	%	(Units)	%	(Units)	%	(Units)	%	(Units)	%	(Units)	%
Recycling	**Total**	**12**	**0.3**	**776**	**18.2**	**14**	**0.3**	**1,229**	**28.8**	**1,942**	**45.4**	**1**	**0.0**	**3,974**	**93.0**
	SUD	11	0.3	715	16.7	14	0.3	1,158	27.1	1,785	41.8	-	-	3,683	86.2
	MUD	1	0.0	61	1.4	-	-	71	1.7	157	3.7	1	0.0	291	6.8
General	**Total**	**46**	**1.1**	**46**	**1.1**	**-**	**-**	**86**	**2.0**	**122**	**2.9**	**-**	**-**	**300**	**7.0**
	SUD	46	1.1	45	1.1	-	-	86	2.0	119	2.8	-	-	296	6.9
	MUD	-	-	1	0.0	-	-	-	-	3	0.1	-	-	4	0.1
Grand	**Total**	**58**	**1.4**	**822**	**19.2**	**14**	**0.3**	**1,315**	**30.8**	**2,064**	**48.3**	**1**	**0.0**	**4,274**	**100.0**

When analysed by weight, although aluminium containers disposed of to the recycling in the 2020 audit were only 2.9% of the total recycling audited, 82.8% of them were eligible for the CDS (Figure 18). Similarly, PET made up 5.1% of total recycling with 47.6% of that eligible for the CDS. Glass containers were an important material category making up a large proportion of overall recycling at 46.5% with over one third of that (35.6%) eligible for the CDS (Figure 18).

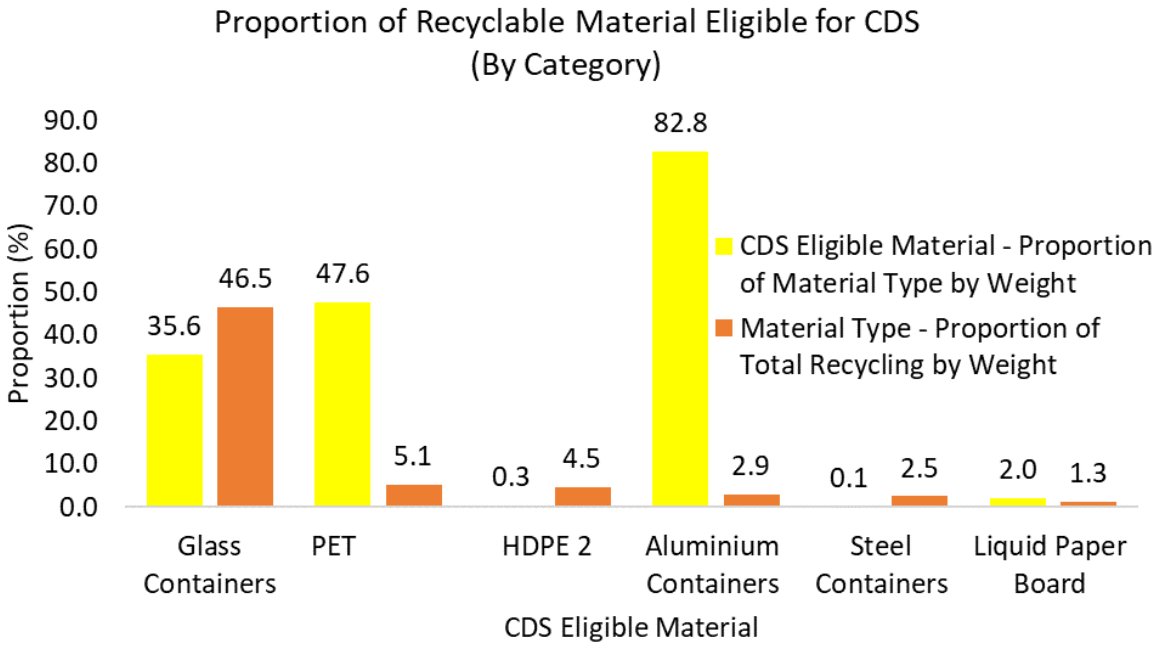


Figure 18 A comparison by weight of the total proportion of each recyclable material category eligible for a refund in the CDS (yellow) compared to the overall proportion of the material type in the total recycling stream (orange).

In comparison, when analysed by volume, glass, PET, and HDPE 2 had similar volumes at 12.7%, 12.5% and 12.1% of total recycling respectively (Figure 19). A very large proportion by volume of the aluminium (90.5%) was eligible for the CDS while just under half of the PET and just over one third of the glass was eligible (Figure 19).

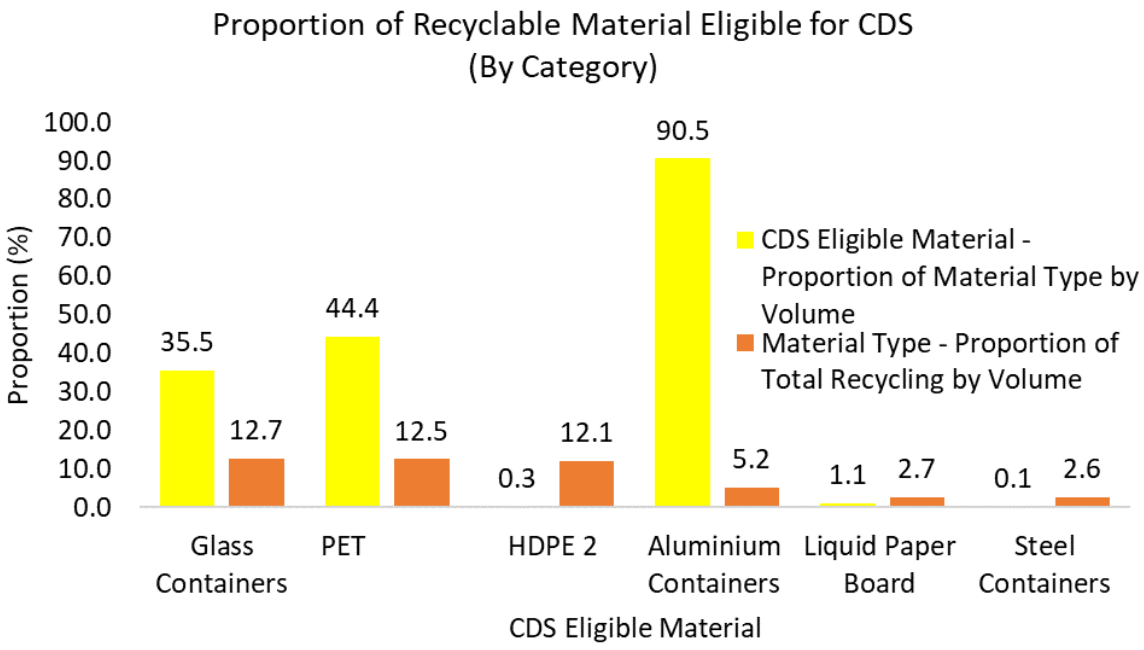


Figure 19 A comparison by volume of the total proportion of each recyclable material category eligible for a refund in the CDS (yellow) compared to the overall proportion of the material type in the total recycling stream (orange).

3.4.1. Breakdown of contamination in the recycling bin

The average contamination rate within the household recycling bins was 6.2% ± 13.8% with a median of 1.1%. There were 166 households, or 68.9%, with a contamination rate below the mean; 42.5% with a contamination rate of zero and 26.4% with a contamination rate between zero and 6.2% (Figure 20). Overall, 73.3% of households had a contamination rate of 5% or less (Figure 20).

The spread of household contamination rates was very much skewed to the right with 13 households, or 5.9%, having contamination rates over 30% (Figure 20). The maximum contamination rate of 96.9% was from a MUD in Snug. The 13 households with a contamination rate greater than 30% were all considered major outliers. By removing the major outliers, the average contamination rate was reduced to 3.3% ± 5.1%.

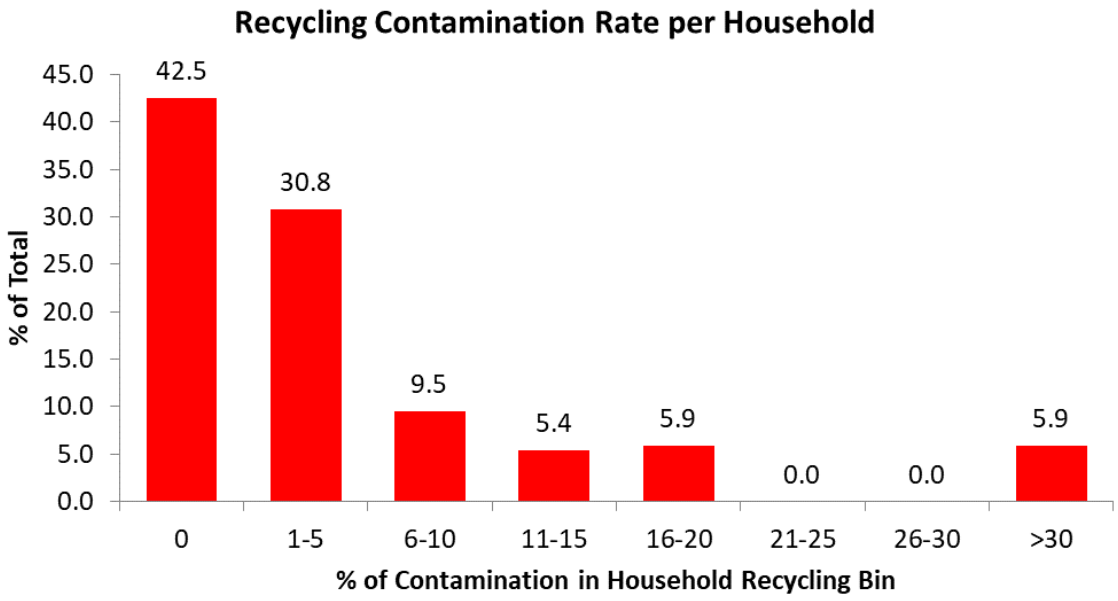


Figure 20 Contamination rate for the recycling bins in the 2020 waste and recycling bin audit.

There was a total of 139 kg or 8.6% of contaminating materials in the recycling stream. Most of the contamination, by weight (48%) was organic material that could be diverted to either the new Green Organics Service (15.8%) or home composting (32.2%) (Figure 21). Plastic bags accounted for 9.8% (by weight) of the contamination however when analysed by volume they composed 51.1% of the contamination (Figure 21). In total, 23.9% by weight or 58.2% by volume, of the contamination could be diverted to an alternative recycling service as listed in Table 6.

Disposable nappies were the most common contaminating landfill items by weight (8%) (Figure 21). The category 'Other Landfill Materials' was composed of rubber, polystyrene 6, expanded polystyrene, building materials, composite plastic/metal non-recyclable and animal waste. This category was 2.6% by weight, or 8.6% by volume. The discrepancy of weight to volume was due to the inclusion of 5.8% (by volume) of expanded polystyrene.

Hazardous contamination within the recycling stream was very low at 0.48%, by weight, of total recycling and came from a total of 7 households (Table 13). The hazardous contamination was made up of paint, household batteries and e-waste and electrical.

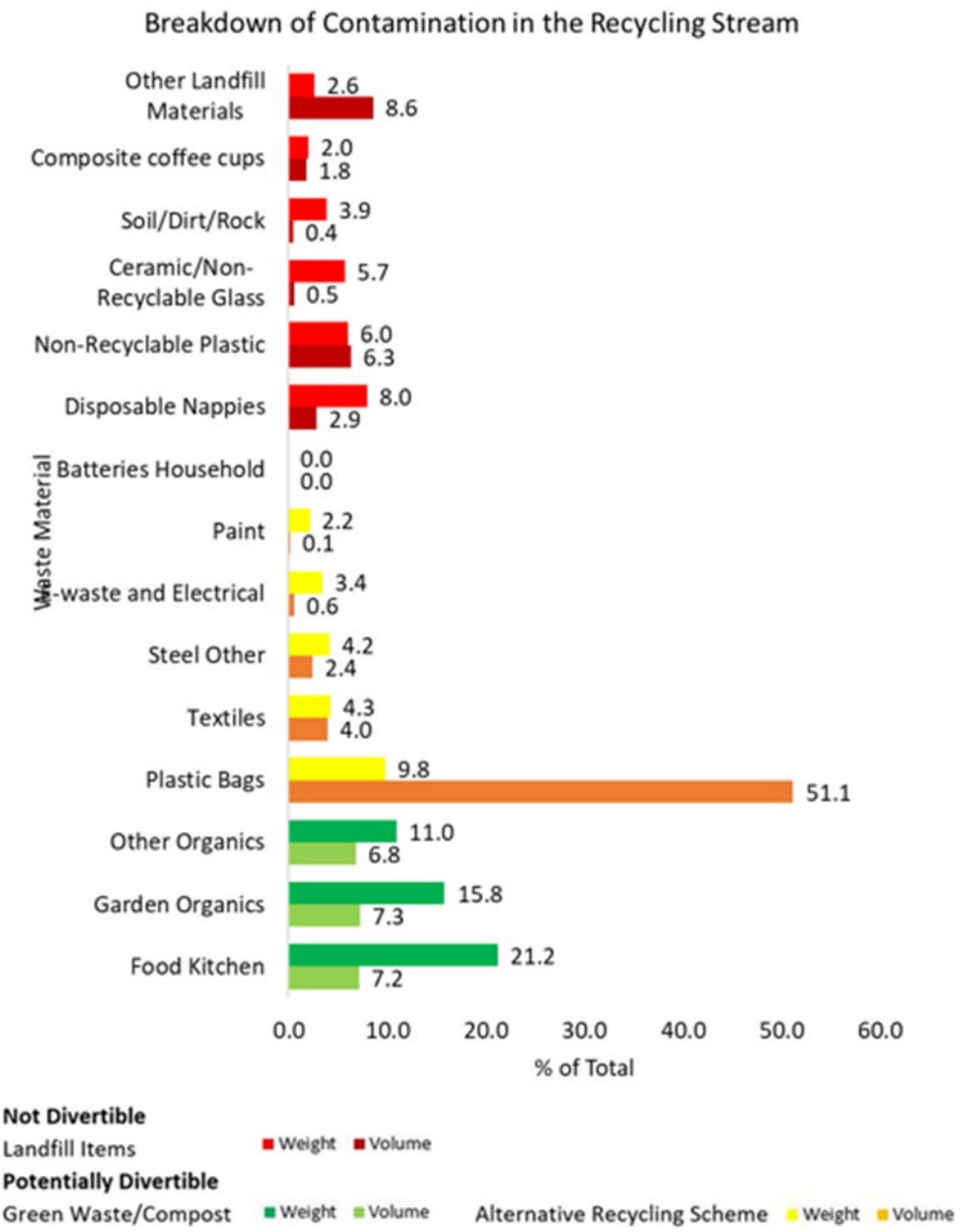


Figure 21 Breakdown of contamination in the recycling stream by weight and volume for the 2020 kerbside waste and recycling bin audit. Items in green are potentially divertible to garden compost, green organics collection or possible FOGO collection, items in yellow are potentially divertible to alternative recycling schemes and items in red are landfill items.

Table 13 Number of households with 'Hazardous' waste and the composition of the 'Hazardous' contamination in the recycling for the 2020 kerbside waste and recycling bin audit.

Hazardous Materials	Number of Households	% of Households	Weight (kg)	% of Recycling
Paint	1	0.5	3.02	0.19
Batteries Household	1	0.5	0.01	0.001
E-waste and Electrical	5	2.3	4.77	0.30
Total	**7**		**7.8**	**0.48**

3.5. Comparison of recycling and general waste bin recyclable content

There were 221 paired sets of recycling and general waste bins audited in the 2020 kerbside waste and recycling bin audit. The paired sets were analysed together in order to create a clearer picture of how households are disposing of their recycling. A total of 1,672 kg of recyclable material was disposed of by the 221 households. In total, 88% (by weight) of the recyclable material was diverted to the comingled recycling stream (Table 14). Glass containers were most commonly disposed of correctly with 93.2% (by weight) being placed in the recycling bin (Table 14). Liquid Paper Board was incorrectly discarded more often with only 36.1% (by weight) of waste being placed in the correct bin. Aerosols were also commonly incorrectly placed in the general waste with only 56.9% diverted by weight and 59.2% by volume (Table 14).

Table 14 Total weight of recyclable materials disposed of by households with paired bins and the % diverted from general waste to the comingled recycling streams in the 2020 kerbside waste and recycling bin audit.

	By Weight			By Volume		
	Recycling Bin (kg)	General Waste Bin (kg)	% Diverted	Recycling Bin (L)	General Waste Bin (L)	% Diverted
Glass Containers	683.8	50.0	93.2	3,657.9	269.0	93.1
Aluminium Containers	42.1	4.5	90.3	1,492.6	111.9	93.0
Paper & Cardboard	511.3	60.4	89.4	13,947.0	1,545.9	90.0
HDPE 2	66.5	8.4	88.8	3,497.5	139.9	96.2
Steel Containers	36.8	6.2	85.5	763.6	35.9	95.5
Plastic 3-7	32.2	9.6	77.0	1,063.3	185.8	85.1
PET 1	74.8	25.2	74.8	3,611.7	824.0	81.4
Aerosols	4.7	3.5	56.9	40.4	27.9	59.2
Liquid Paper Board	18.9	33.5	36.1	780.6	91.7	89.5
Total	**1,471.0**	**201.4**	**88.0**	**28,854.6**	**3,231.9**	**89.9**

All of the paired sets of bins had at least some recyclable material disposed of to their recycling bin although none of them disposed of all 20 recyclable materials (refer to Table 3 for complete list). Most households disposed of 7 (15.4%), 8 (22.2%) or 9 (19.5%) different recyclable materials (Figure 22).

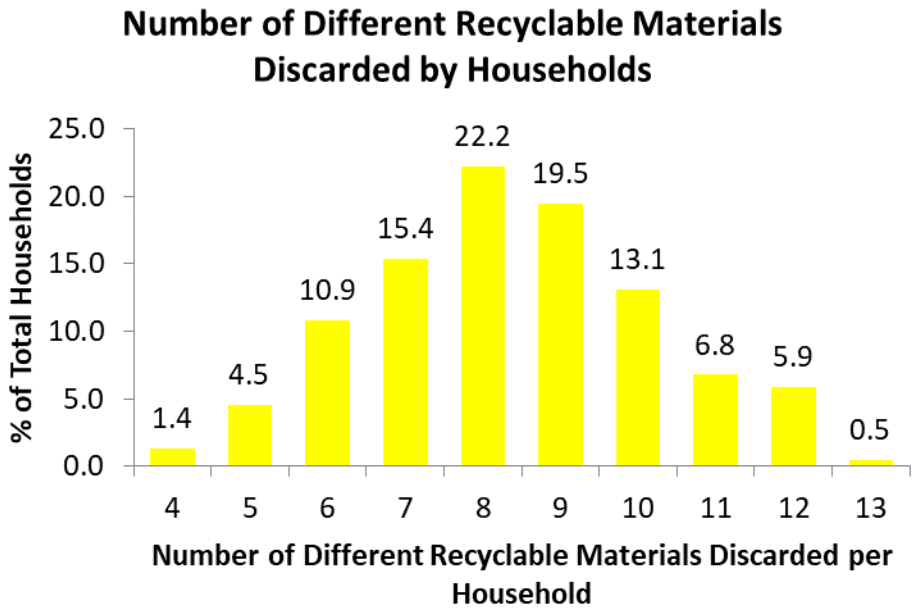


Figure 22 Number of different recyclable materials discarded by households with paired bins in the 2020 kerbside waste and recycling bin audit.

The most often discarded recyclable materials were Cardboard with 99.1% of households disposing of this material (Figure 23). PET 1 and HDPE 2 were also very commonly discarded at 81.9% and 84.7% respectively (Figure 23). Steel containers and HDPE 2 containers eligible for the CDS were the least commonly discarded with 0.4% and 1.7% of households disposing of these materials (Figure 23).

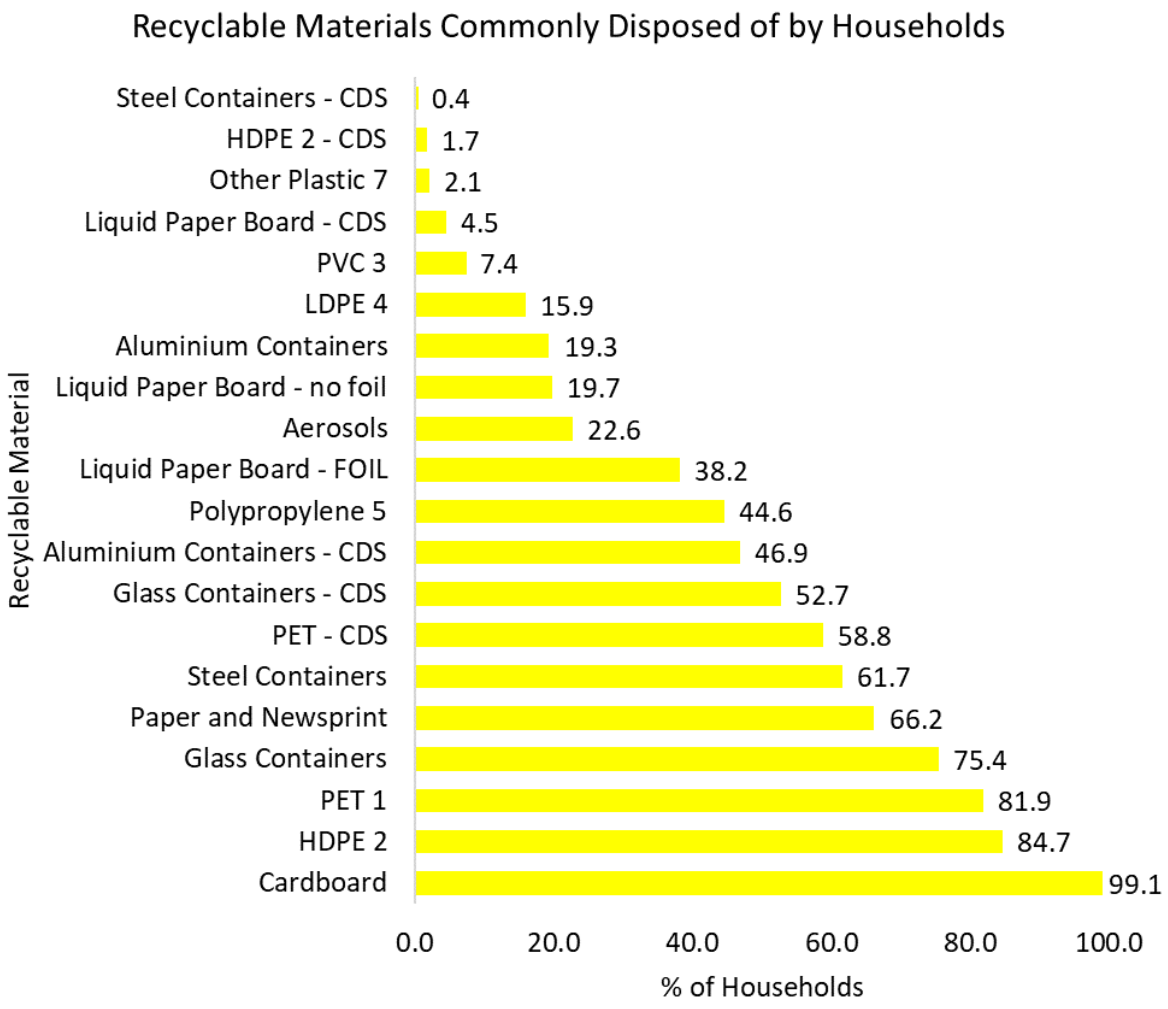


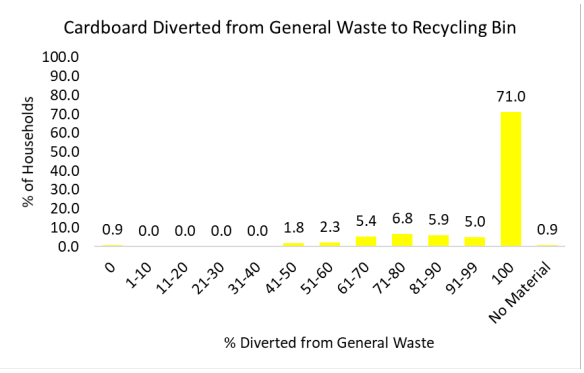
Figure 23 Percentage of households disposing of each type of recyclable material in the 2020 kerbside waste and recycling audit.

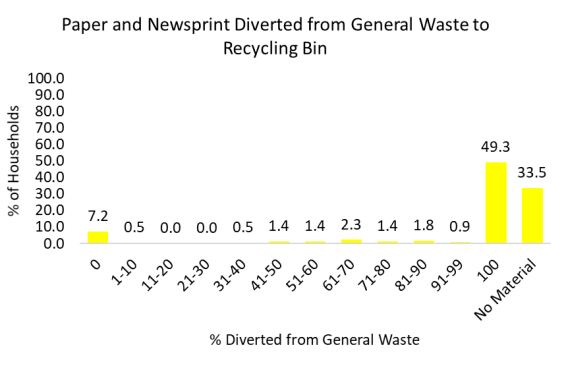
3.5.1. Analysis of Recycling Diversion Rates by Household

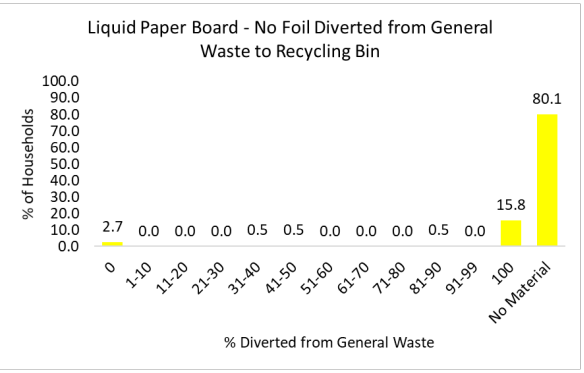
The proportion of households diverting various recyclable materials from the general waste to the recycling bin was analysed by material type. PET 1 was poorly treated with 14.5% of households diverting none of this material to the recycling bin and only 43.9% of households diverting 100% (Figure 24). Approximately 10% of households also diverted none of their aerosols and 9% diverted none of their steel containers to the recycling (Figure 24).

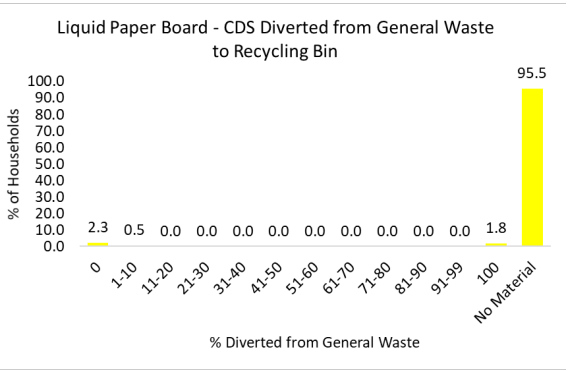
Types of recyclable materials that households often had no material disposed of to either stream included steel containers (99.5%), HDPE 2 – CDS (98.2), other plastic 7 (97.7%), Liquid Paper Board – CDS (95.5%), PVC 3 (92.3%), and LDPE 4 (83.3%) among others (Figure 24).

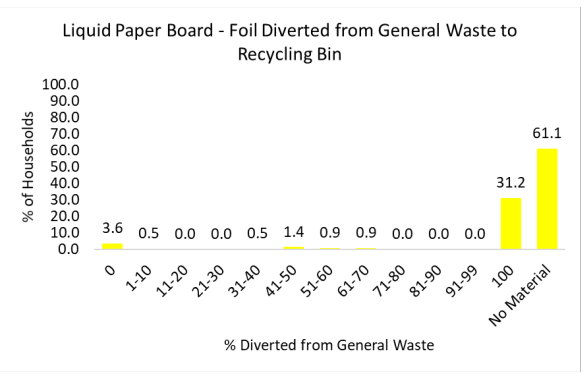
Cardboard, HDPE 2 and glass containers were 100% diverted from the general waste by 71%, 68.3%, and 62% of households (Figure 24).

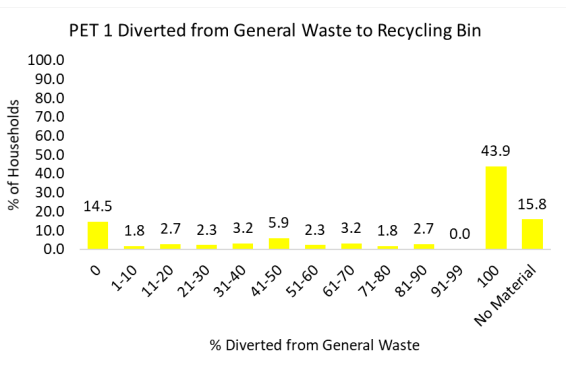

Cardboard Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
0.9 0.0 0.0 0.0 0.0 1.8 2.3 5.4 6.8 5.9 5.0 71.0 0.9
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste

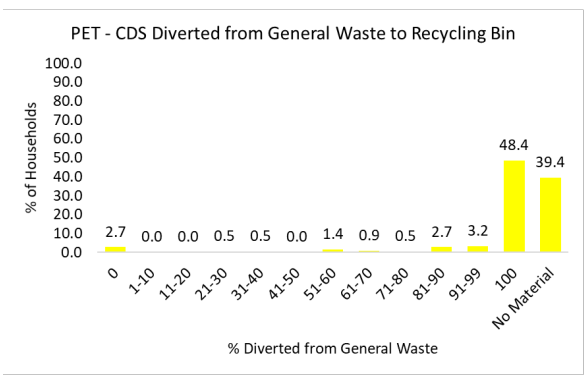

Paper and Newsprint Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
7.2 0.5 0.0 0.0 0.5 1.4 1.4 2.3 1.4 1.8 0.9 49.3 33.5
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste

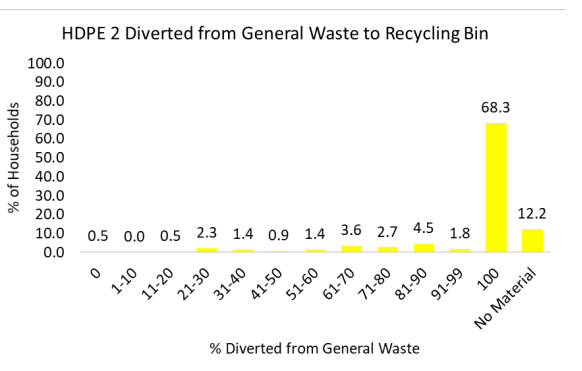

Liquid Paper Board - No Foil Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
2.7 0.0 0.0 0.0 0.5 0.5 0.0 0.0 0.0 0.5 0.0 15.8 80.1
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste

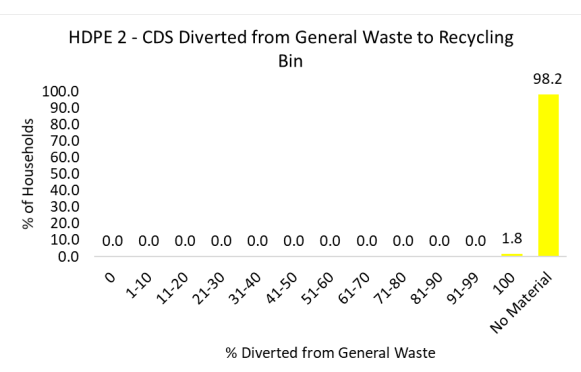

Liquid Paper Board - CDS Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
2.3 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.8 95.5
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste

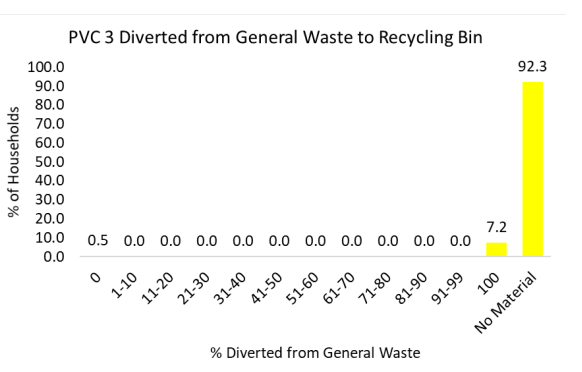

Liquid Paper Board - Foil Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
3.6 0.5 0.0 0.0 0.5 1.4 0.9 0.9 0.0 0.0 0.0 31.2 61.1
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste


PET 1 Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
14.5 1.8 2.7 2.3 3.2 5.9 2.3 3.2 1.8 2.7 0.0 43.9 15.8
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste


PET - CDS Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
2.7 0.0 0.0 0.5 0.5 0.0 1.4 0.9 0.5 2.7 3.2 48.4 39.4
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste


HDPE 2 Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
0.5 0.0 0.5 2.3 1.4 0.9 1.4 3.6 2.7 4.5 1.8 68.3 12.2
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste


HDPE 2 - CDS Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.8 98.2
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste


PVC 3 Diverted from General Waste to Recycling Bin
% of Households
100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0.0
0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 7.2 92.3
0 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-99 100 No Material
% Diverted from General Waste

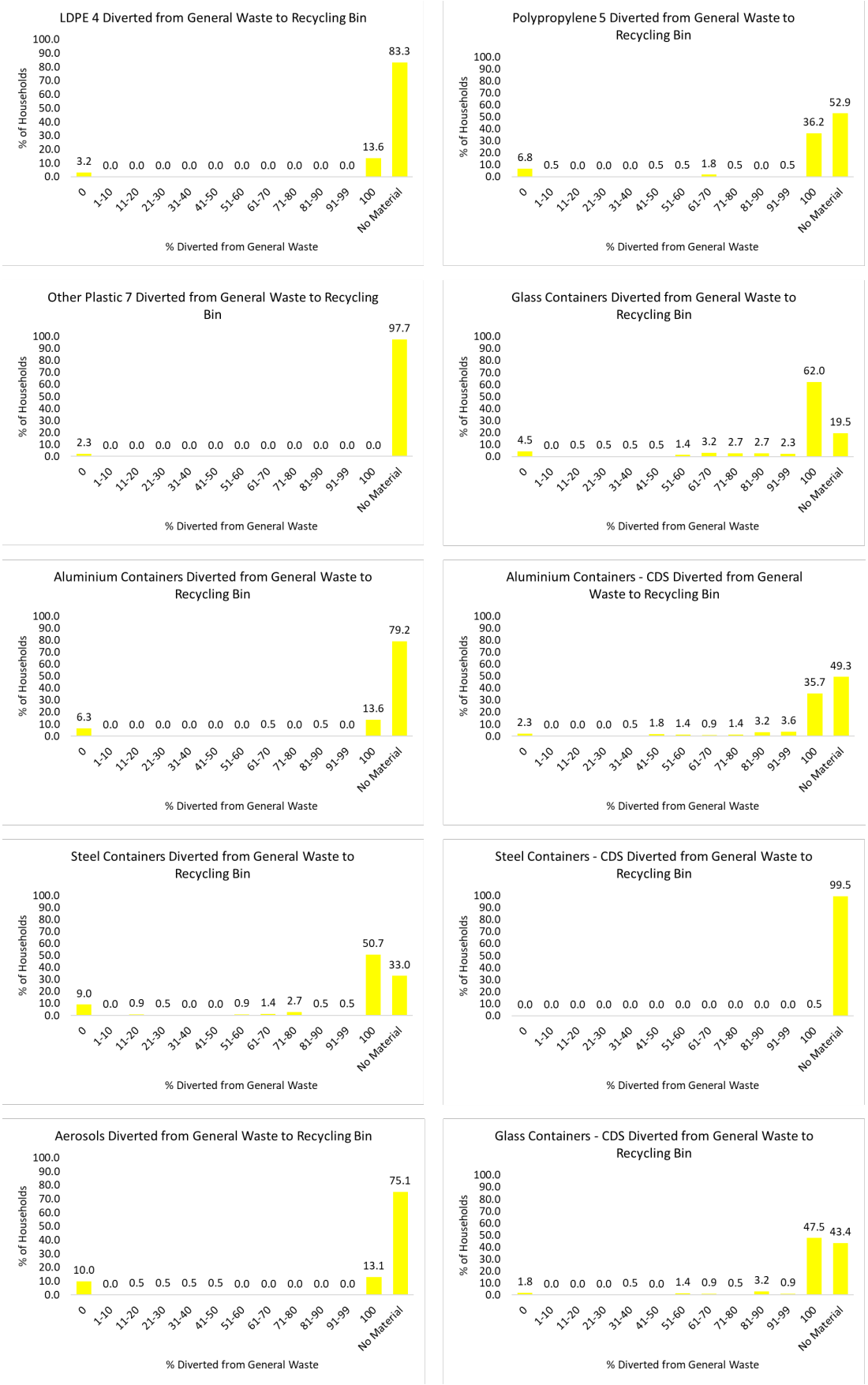


Figure 24 Household diversion rates of recyclable materials from general waste to recycling bins for the 2020 kerbside waste and recycling audit.

4. DISCUSSION

General waste stream

General waste accounted for 52% of total waste by weight and 39% of total waste by volume. The high weight/volume ratio of 1.33 compared to the weight/volume ratio of the recycling stream (0.79) demonstrates that overall, general waste is denser than the more voluminous recycling and would consequently, take less space in the collection truck than the recycling. Nevertheless, general waste is collected twice as often as recycling so, given their similar proportions in this audit, it can be inferred that it is generated at twice the rate of the recycling. Reducing the amount of general waste dumped at landfill has cost benefits in that it saves space in the landfill, provides resources to the resource recovery sector, and reduces the production of harmful greenhouse gasses.

Although only 11% (by weight) of the general waste could currently be diverted to the recycling stream, up to 83% in total could potentially be diverted from this stream with 13% garden waste eligible to be diverted to the upcoming Green Organics Service and another 59% (by weight) potentially divertible to either home compost or various community recycling schemes as outlined in Table 6.

Unfortunately, 8% (by weight) of the overall general waste from this audit had become a contaminate within the recycling stream. Plastic bags made up 51% of this contamination by volume. This is significant because they also made up 25% of the general waste in the general waste stream. The low weight/volume ratio for wastes like plastic bags and expanded polystyrene, pose a problem for waste disposal, taking up valuable space in the collection trucks and landfill. Given that it is widely known that plastic bags are recyclable, it is possible that householders do not realise they should not be placed in the kerbside recycling. Those householders that do realise they should not be placed in the kerbside recycling may be put off by the inconvenience of dropping them of at the REDcycle drop-off points currently available. Given the disproportionate space requirements of plastic bags and expanded polystyrene, it would be a priority to divert these materials from the waste stream.

Most of the general waste contamination in the recycling bins was composed of organic material (48% by weight) with only 15.8% of that eligible for the upcoming Green Organics Service. Organic material also made up 75.7% of the general organics stream by weight although only 14.7% of this was garden organics eligible for the Green Organics Collection Service. The introduction of a FOGO collection service that could accept all 'clean' organic materials could therefore be highly effective at significantly reducing the volume of material currently being disposed of to landfill.

Hazardous waste made up a tiny 1.2% of total general waste however these materials can carry a disproportionate risk of fire and contamination of land, water, and air. Three out of the five hazardous

materials disposed of in the general waste (e-waste, fluoro tubes and X-rays) could potentially be recycled at the Barretta Waste Management Facility. E-waste and electrical was the most discarded hazardous waste which could easily be dropped off at Barretta free of charge. Promotion of this convenient service may encourage households to dispose of this material more responsibly.

In the area analysis of divertible and potentially divertible materials from the general waste, Kingston Beach had the lowest proportion of divertible materials at 60%. They also had the highest proportion of bins 75% full or more. The comparatively lower proportion of potentially divertible waste could indicate that Kingston Beach is already making use of the various alternative recycling schemes available. However, the higher proportion of household bins with a 75% or greater bin fullness could also indicate that they are just disposing of more non-divertible waste in general thus reducing the proportion of divertible waste.

Snug and Taroona both had exceptionally large proportions of potentially divertible materials in their general waste with 89% and 92% respectively. They also had similar proportion of households with bin fullness greater than 75% to Margate and Blackmans Bay which had slightly lower levels of potentially divertible materials at 86% and 81% respectively. This seems to indicate that Snug and Taroona are disposing of proportionally more potentially divertible materials although this does not seem significant enough to warrant a separate educational campaign. It would be beneficial to conduct an educational campaign on proper kerbside recycling and the alternative recycling schemes across all areas rather than a targeted campaign.

An analysis of dwelling style revealed that MUD's disposed of kerbside recycling to the general waste stream less often than SUD's. Despite this, MUD's have 87% potentially divertible materials compared to SUD's which only have 70%. A good part of that (33%) is made up of garden organics which would be divertible to the Green Organics Service. SUD's only had 10% garden organics in their general waste. This difference could be explained by the MUD's general lack of access to a home compost heap, a problem SUD's would be less likely to have. Given kitchen organics make up 41% of the general waste stream for MUD's and 44% for SUD's, implementing a kerbside service to accept this waste category would be very effective at reducing the overall waste to landfill, particularly given MUD's are less likely to compost at home due to lack of space. Organic matter to landfill represents a loss to the resource recovery sector and prematurely fills landfills.

Regarding the high level of divertible recycling in the general waste stream (11% by weight), it is possible that this reflects the publics loss of confidence with the recycling sector after China stopped accepting certain recyclable material from Australia. A series of surveys conducted by the University of NSW demonstrated that the public believes that "the recyclables they put out in their council bins are ending up in landfill" (Snell, 2018). The public perception of recycling as a valuable and useful activity needs to be restored to reverse this trend.

Only 48.5% of households were using their general waste bin to its maximum capacity with 72% of bins weighing 10 kg or less.

Overall, with 100% householder compliance to kerbside recycling, future Green Organics Collection, and householder participation in home composting and community recycling programs, existing and potential, the level of household general waste could be decrease from an average of 8.0 kg ± 5.6 kg per household per bin to 1.3 kg ± 3.6 kg per household per bin. Obviously 100% compliance is very unlikely however this does provide a goal to work towards into the future.

Recycling stream

Recycling accounted for 48% (by weight) of the overall waste disposed of during this audit. Just over 12% (by weight) of all recycling audited became a contaminate in the general waste stream while 8.7% (by weight) of the recycling stream was contaminated with general waste.

Of the 8.7% contamination, 1.4% was garden organics and could be diverted to the planned Green Organics Collection Service, while 4.9% could be diverted to various recycling schemes as outlined in Table 6, leaving just 2.4% (by weight) genuine general waste contamination within the recycling stream.

Organic materials, including kitchen organics and 'other' organics, made up most of the potentially divertible recycling contamination with plastic bags the next most prevalent contaminant.

Taroona had the lowest proportion of contamination at 3%, 2.4% of which could potentially be diverted to alternative recycling streams. Kingston Beach and Snug had the highest level of contamination in their recycling at 13.1% each. Much of the contamination for Snug however was garden organics (7.2%) while Kingston Beach had 8.7% potentially divertible to alternative recycling programs. It is interesting to note that while Kingston Beach had only 4% MUD's audited, Snug had 16%. This could explain the larger proportion of garden organics in the recycling for reasons discussed earlier.

In general MUD's did tend to have higher proportions of contamination (21.6% compared to 7.1% for SUD's) with the majority of that (11.9%) being garden organics which was predominantly from the Snug area, Blackmans Bay being the only other area that had any garden organics contamination (1.2%).

Kingston Beach had the highest proportion of non-divertible, general waste in their recycling (4.3%) and they also had the highest proportion of overfull bins (16.7%) and 70.8% greater than 75% full. Kingston Beach also had 4% of their general waste bins overfull and the largest proportion (87%) of general waste bins greater than 75% full.

Even though 55.7% of recycling bins were 100% full or more, 62% of bins weighed less than the mean of 7.3 kg indicating that the materials disposed of had a lower weight/volume ratio. This is reflected in the large volume of paper and cardboard, PET and HDPE found in the recycling stream.

CDS

The majority of the CDS eligible containers were found in the recycling stream (20% by weight) with only 1% (by weight) in the general waste. MUD's tended to dispose of CDS eligible containers less often than SUD's. Perhaps this could be explained by family demographics and consumption patterns however further investigation would need to be done to confirm this.

Although aluminium containers made up a small proportion of the overall recycling stream, almost all of them (82.8% by weight and 90.5% by volume) were eligible for the CDS. PET and glass containers also made up around 13% (by volume) of the total recycling with a large proportion of both eligible for the CDS (44.4% and 35.5% respectively). On a per unit basis, aluminium containers accounted for 2,064 units (48.3%) while glass accounted for 1,315 units (30.8%). PET only accounted for 822 units or 19.2%, making glass and aluminium the most discarded CDS eligible containers. Overall, the introduction of the CDS into Tasmania has the potential to reduce the overall recycling waste stream by 20% while providing both KC and the public with financial benefit.

At present, the NSW container deposit scheme offers a refund of 10 c per unit for all eligible containers so the net value of the discarded containers under this scheme is $427.40.

Recycling diversion from general waste

During this audit, all bins were collected in recycling/general waste pairs so that an analysis of diversion rates could be conducted.

Overall, 88% (by weight) of all recyclable materials were diverted from the general waste. Glass containers had the highest diversion rate at 93.2% (by weight), while liquid paper board had the lowest diversion rates 36.1% (by weight). When analysed by volume, liquid paper board had a diversion rate of 89.5%. This discrepancy can be explained by looking at the weight/volume ratio of the material in the recycling (0.02) compared to the weight/volume ratio in the general waste (0.36). The large discrepancy in ratios seems to indicate that households disposing of their liquid paper board to the

general waste crush the containers, thus reducing the volume, however when disposed of to the recycling, these containers are left intact. Most of this material is still disposed of to the general waste with 33.5 kg compared to 18.9 kg in the recycling.

Paper and cardboard are treated in an opposite fashion to the liquid paper board with a weight/volume ratio for recycling of 0.37 and 0.04 for the general waste. This could possibly be explained by a householder's tendency to place paper and cardboard in neat piles in the recycling but when placed in general waste it is often scrunched up or shredded increasing its volume.

The weight/volume ratios of HDPE 2 and steel containers also seem to indicate these items are crushed when disposed of to the general waste but left intact in the recycling.

Aerosol cans were often incorrectly placed in the general waste with a diversion rate of only 56.9% (by weight).

Most households (54.4%) disposed of 8 or less different types of recyclable items in their recycling while 45.6% placed from 9 to 13 different types. Cardboard was the most disposed of material with 99.1% of households disposing of this material to the recycling and 71% of them disposing of 100% of their cardboard correctly. This was followed by HDPE 2 and PET 1 with over 80% of households disposing of this material. Only between 47% and 53% of households disposed of CDS eligible aluminium, glass, and PET containers however those households that did dispose of these materials, disposed of 100% of them to the recycling.

Steel CDS eligible cans were only disposed of by 0.4% of households which is not surprising given this style of drink container has mostly been replaced with the aluminium container. All households with this material however, disposed of it correctly to the recycling. CDS eligible HDPE 2 and liquid paper board were also disposed of by very few households, which again, is not surprising given the PET containers are far more commonly sold. Again, HDPE 2 was disposed of correctly to recycling by 100% of household with this material while households were more likely to dispose of CDS eligible liquid paper board to the general waste. This is interesting given that most households with non-CDS eligible liquid paper board disposed of it correctly to the recycling.

5. RECOMMENDATIONS

MUDs tend to have much higher levels of organic materials in both their general waste and their recycling when compared to SUDs. This is composed of both garden organics and kitchen organics. This is most likely because MUDs have limited space in the kitchen available to physically separate organic materials and no defined outdoor space in which to locate a compost bin for both kitchen and garden organics making home composting impractical. Offering the new Green Organics Collection Service to MUDs that have more than three units, on an opt in basis, could help to reduce this contamination. Additionally, upgrading the service to a full Food Organics, Garden Organics (FOGO) service would help to divert approximately 28% of organic material from the general waste and recycling.

Alternative organics management options include(Sustainability Victoria, 2019):

- Dehydrators
- In-sink waste disposal units
- Domestic bio-digesters

These options do require some investment however and are best included in the design phase of new units. A directed educational campaign would be required at the planning stage of domestic MUD and SUD.

MUDs also have more contaminating materials that are potentially divertible to alternative recycling schemes in their kerbside recycling compared to SUDs. There could be many reasons for this, for example, according to the Australian Bureau of Statistics (2017), 21% of residents living in apartments do not own a car compared to less than 5% for residents living in separate houses. This could make it difficult for householders in MUDs to drop potentially recyclable materials off at recycling centres and drop-off locations. They may also have limited space in which to store these materials making it significantly more convenient to just dispose of them into the general waste or kerbside recycling. Information on how to set up a suitable shared storage area for residents of MUDs where materials such as plastic bags, textiles, steel, e-waste and electrical, paint and batteries can be safely stored for later delivery to approved recycling facilities and drop-off locations could be helpful.

The Kingborough Volunteer Program could also include a recyclable waste collection service for residents unable to visit recycling facilities and drop-off locations themselves.

There could still be some confusion about what can be included in the recycling with many households including plastic bags, textiles, non-recyclable steel, e-waste, non-recyclable glass, coffee cups and non-recyclable plastic. Given the availability of separate recycling schemes that do accept these materials, it is easy to see why the confusion exists. An educational campaign on proper kerbside recycling and the alternative recycling schemes available should be conducted with emphasis on items that seem to

be particularly confusing to households such as, liquid paper board and plastic bags. Perhaps the provision of a magnetic information leaflet which includes details of items that can be recycled through alternative means, and the location of these drop-off points would also be beneficial.

Rebuild community confidence that the raw materials from the kerbside recycling service are being recovered and not diverted to landfill.

The introduction of the CDS has the potential to divert up to 20% (by weight) of the recycling from the kerbside collection. This service would provide financial benefit to both KC, through a reduced volume of recycling, and the householders through the refund offered by the scheme. This scheme should be promoted in advance of its implementation so that householders are aware of and supportive of the scheme.

Continue to conduct kerbside waste audits after the introduction of the Green Organics Collection Service.

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APPENDIX 1 – GENERAL WASTE TABLE

General Waste Data		Weight	
Bin	Material	kg	%
Recycling	Cardboard	22.26	1.3
	Paper & Newsprint	38.09	2.1
	Liquid Paper Board	33.52	1.9
	Plastic 1-7	43.15	2.4
	Glass	50.03	2.8
	Aluminium, steel & aerosols	21.95	1.2
FOGO	Kitchen organics	767.79	43.3
	Garden organics	230.46	13.0
	Soiled paper & cardboard	126.81	7.2
	Untreated timber	4.88	0.3
	Compostable packaging	2.24	0.1
	Hair	0.62	0.0
	Ash	13.25	0.7
General Waste Data	Composite coffee cups	3.73	0.2
	Composite plastic/metal non-recyclable	0.00	0.0
	Ceramic/non-recyclable glass	10.23	0.6
	Animal waste (poo)	70.26	4.0
	Non-recyclable plastic (rigid)	15.27	0.9
	Rubber	0.31	0.0
	Foam	0.00	0.0
	Recycling in plastic bags	0.00	0.0
	Containers containing food or liquid	0.00	0.0
	Plaster	0.00	0.0
	Bagged domestic waste	0.00	0.0
General Waste - Hazardous	Treated timber	3.37	0.2
	Clinical/pathogenic/infectious	1.23	0.1
	Paint	0.00	0.0
	Fluro tubes	0.18	0.0
	Batteries car	0.00	0.0
	Batteries household	0.00	0.0
	Chemicals	0.00	0.0
	E-waste & electrical	29.42	1.7
	Disposable nappies	115.50	6.5
	X-Ray	0.07	0.0
General Waste - Resource Recovery Potential	Building materials	31.12	1.8
	Soil/Dirt/Rock	37.79	2.1
	Steel other	0.00	0.0
	Plastic bags	63.22	3.6
	Polystyrene 6	1.14	0.1
	Expanded polystyrene	2.48	0.1
	Textiles	31.30	1.8
Total		**1771.7**	**100.0**

APPENDIX 2 – RECYCLING TABLE

Recycling Data		Weight	
Bin	Material	kg	%
Recycling	Cardboard	265.38	16.5
	Paper & Newsprint	245.89	15.3
	Liquid Paper Board	18.90	1.2
	Plastic 1-7	173.46	10.8
	Glass	683.76	42.5
	Aluminium, steel & aerosols	83.57	5.2
FOGO	Kitchen organics	29.58	1.8
	Garden organics	22.04	1.4
	Soiled paper & cardboard	12.02	0.7
	Untreated timber	0.37	0.0
	Compostable packaging	1.17	0.1
	Hair	0.00	0.0
	Ash	1.73	0.1
General Waste Data	Disposable nappies	11.15	0.7
	Composite coffee cups	2.79	0.2
	Composite plastic/metal non-recyclable	0.37	0.0
	Ceramic/non-recyclable glass	7.94	0.5
	Animal waste/faeces	0.06	0.0
	Non-recyclable plastic (rigid)	8.34	0.5
	Rubber	1.28	0.1
	Foam	0.00	0.0
	Recycling in plastic bags	0.00	0.0
	Containers containing food or liquid	0.00	0.0
	Plaster	0.00	0.0
General Waste - Hazardous	Bagged domestic waste	0.00	0.0
	Treated timber	0.00	0.0
	Clinical/pathogenic/infectious	0.00	0.0
	Paint	3.02	0.2
	Fluro tubes	0.00	0.0
	Batteries car	0.00	0.0
	Batteries household	0.01	0.0
	Chemicals	0.00	0.0
	E-waste & electrical	4.77	0.3
	X-ray	0.00	0.0
General Waste - Resource Recovery Potential	Building materials	0.57	0.0
	Soil/Dirt/Rock	5.40	0.3
	Steel other	5.84	0.4
	Plastic bags	13.63	0.8
	Polystyrene 6	0.77	0.0
	Expanded polystyrene	0.60	0.0
	Textiles	6.01	0.4
Total		**1610.4**	**100.0**