CITY OF BURNSIDE HOUSEHOLD BIN-BY-BIN AUDIT RESULTS

Final report, July 2022

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EastWaste

The University of Adelaide

Food Waste CRC

Government of South Australia
Green Industries SA

rawtec

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Glossary

Terms	Definition
C&D (Building waste)	Construction and Demolition Waste. Materials or items typically disposed of by the building industry (e.g. fittings, plaster, treated timber).
Comingled recycling bin	Kerbside collected 240 litre yellow lidded bin provided to residents by councils for non-organic recyclable items which are processed at a Material Recovery Facility (MRF) into various resources (e.g., paper cardboard, LPB, glass, metal and rigid plastic containers, and other recyclables).
Composting	The process whereby organic materials are microbiologically transformed, mostly under controlled aerobic conditions, to achieve pasteurization and a specified level of maturity. Allows for the recycling of organic material and contributes to a circular economy.
Contamination	Material placed in the collection bin stream that is not accepted within that stream.
Edible food	Food that is intended to be eaten.
E-waste	Includes electronic waste that is banned from landfill in SA, including batteries, small E-waste items (e.g., mobile phones, chargers) and large e-waste items (e.g., white goods, kitchen appliances, cables etc.)
Food waste	Food and inedible parts discarded through kerbside systems, where 'food' is defined as any substance that was at some point intended for human consumption.
Hazardous waste	Includes waste that is potentially hazardous to human health or the environment that should be specially handled and disposed of for example light globes (e.g., fluorescent tubes), medical waste (e.g., needle sticks, bio contaminants, pills, drugs), other hazardous material (e.g., gas bottles, chemicals, engine oil, paint tins containing paint, asbestos).
Inedible food	Components of food that are not intended to be eaten. For example, eggshells.
Landfill	Location where materials are sent, which are then buried underground.
Material recovery facility (MRF)	Specialized plant that receives, separates and prepares recyclable materials for marketing to end-user manufacturers.
Material separation efficiency	Material separation efficiency is the proportion of a material by weight that is disposed into the correct bin out of the total amount of that material discarded in all the bins.
Organics bin	Kerbside collected 240 litre green lidded bin provided to residents by councils for organic items or materials suitable for composting (e.g., food waste, garden waste, certified compostable liners, and packaging).
Recycling	The process of collecting and processing materials through kerbside systems that would otherwise be thrown away and converting them into new products.

Residual waste	Includes materials or items not suitable for disposal into comingled recycling or organics recycling bins (e.g., soft plastics, textiles, Pyrex/ window glass, crockery, polystyrene and foam packaging and trays, etc.).
Residual waste bin	Kerbside collected red or blue lidded household bin (typically 140 litre) provided to households by councils for residual waste. Commonly also called general waste or landfill bin.
Unrecovered resources	These are recyclable materials disposed into residual waste bins that could be recycled through the comingled recycling, organics bin, or drop-off at a recycling facility (e.g., e-waste, which is recyclable through drop off e-waste recycling stations/facilities around Adelaide) if separated appropriately.

Executive summary

East Waste is collaborating with the Fight Food Waste Cooperative Research Centre (CRC), the University of Adelaide, Green Industries SA, and Rawtec on the *WWW (What, Where and Why) of Household Food Waste Behaviour* project. This project provides deeper insights into at-home food disposal behaviours.

As part of the study, project partners commissioned South Australia's first large-scale household bin-by-bin kerbside audit. The bin-by-bin method involves collecting and auditing individual bins. It provides insights into waste and recycling quantities and performance at the individual household level (rather than aggregated averages). The audit sample included 214 households from across the City of Burnside.

This report, prepared by Rawtec, summarises the audit findings. These findings can be used by project partners to design more effective programs to reduce household food waste, lower bin contamination, and increase landfill diversion performance.

Food waste disposal

On average households are discarding 3.6 kg of food waste per week. Most of this food waste (64 per cent) was avoidable (i.e. it consisted of edible food).

Food waste disposal varies a lot by household

Close to a quarter of households (23.4 per cent) discard no or low amounts of food waste (< 1 kg per week). Nearly a quarter of households again (23.4 per cent) discard very high amounts of food waste (>5 kg per week).

Food waste recycling

On average households are recycling just 22 per cent of their food waste through kerbside systems (by weight). Food waste recycling behaviours vary significantly by household.

Nearly half of households are not recycling any food waste through kerbside systems

Nearly half (47 per cent) of households are not recycling any food waste via the organics bins. These households are disposing of food waste in residual kerbside bins.

On the other hand, 1 in 4 households are high food recycling performers

Nearly a quarter (24 per cent) of households are recycling a large proportion of their food waste (more than 80 per cent by weight) via organics bins.

Residents that recycle their food waste typically use compostable bags

Of the households that recycle their food waste, most (81.5 per cent) are using compostable bags to do so. Households that use compostable bags, use about 1.5 bags per week on average.

A small proportion of households did not present any food waste

Close to 3 per cent of households did not present any food waste in their kerbside bins. This could be for a range of reasons, such as composting their food waste at home.

Households are typically better at recycling their fruit and vegetables

On average, nearly a quarter of all fruit and vegetables are placed into kerbside organics bins. In contrast, just 6 per cent (by weight) of meat, poultry and fish is recycled via kerbside organics bins, with the rest disposed to residual waste bins. The top performing households are good at recycling all food types. In contrast, the middle-performing households (those with food diversion between 40 and 80 per cent by weight) are far better at recycling their fruit and vegetables than other food items.

Contamination behaviours

Reducing contamination in both the organics recycling and comingled recycling streams should remain a high priority. It was found that contamination behaviours vary a lot by household. Hence, a highly targeted program may help manage contamination levels.

Most households have low levels of organics bin contamination

Organics bins have average contamination levels of 4.1 per cent (by weight). This is double the Adelaide metropolitan councils average of 2 per cent[1]. Interestingly, most households (82.7 per cent) have very low levels of contamination (less than 0.5 per cent by weight). This means the average contamination rate for the organics stream is largely driven by a small proportion of households who are grossly contaminating their bins. An estimated 8 per cent of households have contamination levels more than 10 per cent (by weight).

More than half of households have low levels of comingled recycling contamination

The average contamination of comingled recycling material is 10.1 per cent by weight. This is lower than the Adelaide metropolitan councils average of 13 per cent[1]. Contamination levels vary a lot by household. More than half of households (55 per cent) have very low amounts of contamination (<2 per cent by weight). A further 22 per cent of households have contamination between 3 and 10 per cent by weight. Almost a quarter of households (23 per cent) have high levels of contamination (>10 per cent by weight contamination).

[1] Adelaide Metropolitan Area Kerbside Waste Performance Report 2016-17, Green Industries SA, 2019

Contents

1. Introduction and audit methodology

Introduction

An estimated 1.8 million tonnes (or 73 per cent) of household food waste is landfilled each year[2]. Typically, food waste constitutes between 30-50 per cent of the residual bin. Diverting food waste from landfill is one of the biggest financial and environmental opportunities for councils. It also creates local jobs. An estimated 9.6 full time jobs are created for every 10,000 tonnes of organics sent to a composting facility, compared to 3.6 jobs when sent to landfill.[3]

East Waste is collaborating with the Fight Food Waste CRC, the University of Adelaide, Green Industries SA and Rawtec on the *WWW (What, Where and Why) of Household Food Waste Behaviour* project. The box below highlights the relative contribution to knowledge from this audit.

Importance of the audit

This kerbside audit provides new and in-depth insights into household food waste behaviours. To the best of the authors' knowledge, our audit is unique to Australia given:

- The bins were audited at an individual level across three waste streams that could be matched to the same household. Thus, the audit provides insights into food waste quantities and performance at the individual household level, rather than aggregated averages, and
- Food waste was sorted on presentation, food type and edibility:
    - the first sort identified how the food was presented in the bin (e.g. loose, in a compostable bag, packaged in containers/bags)
    - the second sort identified the food type (meat, poultry, and fish, dairy and eggs, fruit, vegetables, bread, pasta/ rice/ cous cous, beverages, other pantry items, and takeaway food). This revealed food waste generation types, and tendencies for how residents discard different food types
    - the third sort was to estimate the proportion of food waste that was avoidable (i.e. food that was intended for human consumption), as opposed to unavoidable (e.g. inedible parts, like bones).

The audit findings help to answer questions, such as:

- How does food recycling performance vary by household?
- Is overall contamination of the organics stream driven by a few households that are grossly contaminating their bins?
- Are households that are good at recycling their comingled materials (e.g. paper, metals, glass) also good at recycling their food waste?
- Of the total households recycling their food waste via kerbside bins, what proportion are using compostable bags?

University of Adelaide, East Waste, Green Industries SA and Rawtec developed the audit aims, methodology, audit categories and data collection sheets, peer reviewed the sampling methodology, and supervised audit bin collections. Rawtec reviewed and undertook necessary adjustments to the data, and completed the analysis, under supervision and with data support and review by the

[2] FIAL. (2021). The National Food Waste Strategy Feasibility Study – Final Report.
[3] Green Industries SA. (2021). SA Organics Sector Analysis.

University of Adelaide. Finally, Rawtec summarised the findings and prepared this report in conjunction with partners.

This report presents the findings from the audit and provides a new level of insight into household waste, recycling, and organic bin use behaviour. Audit findings will be used to deliver targeted education, behaviour change and incentive-based programs.

The data analysis and findings of this report aim to bridge the gap and build on what is known by providing a greater understanding of waste and recycling systems currently operating in SA and their performance. Improving knowledge about food waste and recycling behaviours will allow research partners to design more effective programs to reduce household food waste and recyclable materials from entering landfill.

1. Methodology

1.1 Demographic sampling

The project aimed to audit kerbside bins (residual waste, organics and comingled recycling) from 200 households from across the City of Burnside. The City of Burnside was selected because Council-owned mobile garbage bins are fitted with small RFID (Radio Frequency Identification Device) chips that enables the identification of the bins. Waste collection trucks are fitted with technology to read the RFID chips and scales to weigh the bins. This weighing mechanism on the collection vehicles have been in place for some time, enabling the possibility that weight data could be obtained pre and post audit, subject to quality issues with data collection.

Australian Bureau of Statistics (ABS) profile information[4] was used to select the streets in advance of the audit to determine the audit sample and obtain an accurate representation of household size (number of persons), household income, and ethnicity.

Households in the audit area were provided a letter 6 weeks in advance notifying them about the upcoming audit and giving them the opportunity to opt out (see Appendix 5). The exact date was not given and the lag time between delivery of the letter and carrying out of the audit was intentional in order to avoid deliberate behaviour change. Out of around 1350 letters delivered to 10 suburbs within the City of Burnside, 53 houses opted out of the audit initially. Three more households opted out following the audit and were removed from the audit collection.

1.2 In-field sampling method

The sampling method considered the SA Guide to Kerbside Performance Reporting[5]. However, this approach was adapted given it was a bin-by-bin audit.

The sampling involved:

- Collecting bins from sampled streets (see section above).
- Only collecting bins from single-unit dwellings (SUDs). Multi-unit dwellings (MUDs), businesses, churches or retirement villages were excluded from the audit.
- Collecting bins from every second household on sampled streets, unless:

[4] Sourced from analysis of ABS data provided by profile.id.com.au/.

[5] Zero Waste SA. (2007). SA Guide to Kerbside Performance Reporting.

- the bins were overfull, had personalised stickers or markings
- the households had multiple bins from the same waste stream (e.g. 2 organics bins)
- the household had opted out from the bin-by-bin audit
- the households did not receive a letter notifying them of the audit and of the option to opt out

- Marking the bin to be audited with a unique bin ID. This allowed for the bins collected from the same household to be matched (e.g. the residual waste bin was marked R001, and the corresponding comingled recycling and organics bins were marked Y001 and G001, respectively).
- Swapping the bins to be audited with new bins.
- Delivering the collected bins to the East Waste depot (1 Temple Court, Ottoway) for physical auditing.

The audit took place on residents' regular collection day in March/April 2021 and was scheduled to avoid public and school holidays. An audit supervisor accompanied the truck to ensure the bins were sampled from the selected streets and in line with the agreed sampling method.

The bins were collected over 2 weeks (10 days of auditing). Residual waste and organics bins were collected during the first week from households. This ensured that matched residual waste and organics bins could be collected and audited. The comingled recycling bins were collected the following week and households audited the previous week (with already collected residual waste and organics bins) were targeted. The project sought to audit 200 households and their 3 bins from across the City of Burnside (600 bins in total). To ensure that matched residual waste, comingled recycling and organics bins from the same household were collected and audited, the project delivery team collected additional bins. Some of the households that residual waste and organics bin were collected from, did not present their comingled recycling bins the following week. This resulted in auditing 175 households with 3 matching bins (25 households short of the initial target).

Table 1 below summarises the number of bins collected as part of the audit and how many matched the same households.

	Number of bins / sets audited
Residual waste bins	214
Organics bins	214
Comingled recycling bins	215
Households with matched pairs (residual waste and organics)	208[6]
Households with matched triplets (residual waste, organics, and comingled recycling bins)	175

Table 1: Number of collected bins and number of households with matched bins

[6] The auditors were only able to match 208 organics and residual waste bins out of the 214 bins collected. This was due to data entry errors on unique IDs which impacted 6 bins.

1.3 Physical auditing method

The physical auditor undertook the following steps when auditing bins:

- Record the unique bin ID (based on tag/mark on the bin) and note the stream (e.g. organics, comingled recycling, or residual waste), bin size (litres) and bin content volume (%).
- Weigh the full bin.
- Empty the bin contents, and sort and weigh the contents into agreed categories (see Appendix 3 for audit categories).
- Record the findings.

1.4 Analysis of audit data

Where values are presented 'per household per week' (e.g. for waste generation, number of compostable bags disposed of into bins by households), these have been adjusted for frequency of collection and presentation rates (provided by East Waste) for the different bin types for the Council (Table 2).

Material stream	Collections per week	Average bin presentation rates
Residual waste	1	88%
Comingled recycling	0.5	80%
Organics	0.5	75%

Table 2: Information on collection frequency and average bin presentation rates for the City of Burnside for the month of March

2. Results – overview of how residents use kerbside bins

2. Overview of how residents use kerbside bins

This section provides an overview of how residents use the three-bin system. It presents findings on:

- **Bin fullness** (i.e. how full kerbside bins are on average, and how this varies by household)
- **Bin composition** (i.e. what types of materials residents are placing in the bins)
- **Landfill diversion performance** (i.e. what proportion of material is diverted from landfill, and how this varies by household)
- **Material separation efficiencies** (i.e. how effective residents are at separating different types of recyclables)

2.1 How full are the kerbside bins?

Across the households with 3 matched bins, on average:

- the residual waste was 44 per cent full
- the comingled recycling bin was 60 per cent full
- the organics bin was 67 per cent full

Figure 1 provides a breakdown of residual waste bin fullness by household. 63.1 per cent of households presented residual waste bins that are less than half full. Less than 9 per cent of households presented residual waste bins over 90 per cent full.

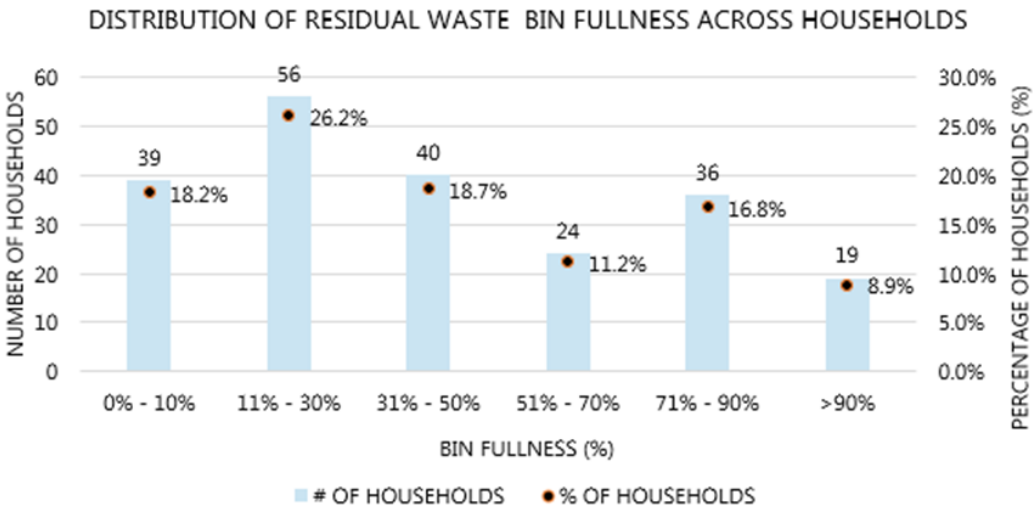


Figure 1: Distribution of bin fullness for residual waste bins across households

2.2 What are people putting in the kerbside bins?

The composition of the bins provides insights on what residents are disposing and how well they source separate their recyclables. The composition is outlined based on the weight of the materials as a percentage of the total.

Residual waste bins

The total weight of the material collected from the 214 residual waste bins from the 214 audited households was 1520 kilograms. The composition of this material (as per the audit categories outlined in Appendix 3) is outlined in Figure 2. Figure 2 shows:

- Unrecovered resources made up nearly half of the residual waste bin, or 47 per cent.
- Food waste made up 38 per cent of the total weight of residual waste bins. This includes unpackaged (loose) food (30 per cent) and packaged/containerised food (8 per cent) that could be recovered if properly separated before disposal. The total volume of food waste in the residual waste bins is 2.79 kilograms per household per week.
    - For almost half of all households (46.7 per cent), compostable materials (mostly food waste) made up between 30 and 70 per cent by weight of their residual waste bin (Figure 3). 24.3 per cent had between 30 and 50 per cent compostable materials content in their residual waste bins, and 22.4 per cent had between 50 and 70 per cent compostable materials.
    - Only 6.5 per cent of households had no, or almost no compostable materials (<0.5 per cent) in their residual waste bin (Figure 3).
- Almost 13 per cent of the residual waste bin was made up of materials that can be recycled through the kerbside comingled system (e.g. recyclable glass, paper/cardboard, plastics, etc.)[7].
    - For 43.5 per cent of households, recyclable materials made up between 11 and 30 per cent by weight of their residual waste bin (Figure 4).
    - 7.9 per cent of households had no or almost no (<0.5 per cent) recyclable materials in their residual waste bin (Figure 4).
    - Almost 10 per cent of households had over 31 per cent recyclable materials in their residual waste bin (Figure 4).

[7] Soft plastics can be recycled, but not through the kerbside systems. Residents can drop off soft plastics for recycling at participating supermarkets through the RedCycle initiative.

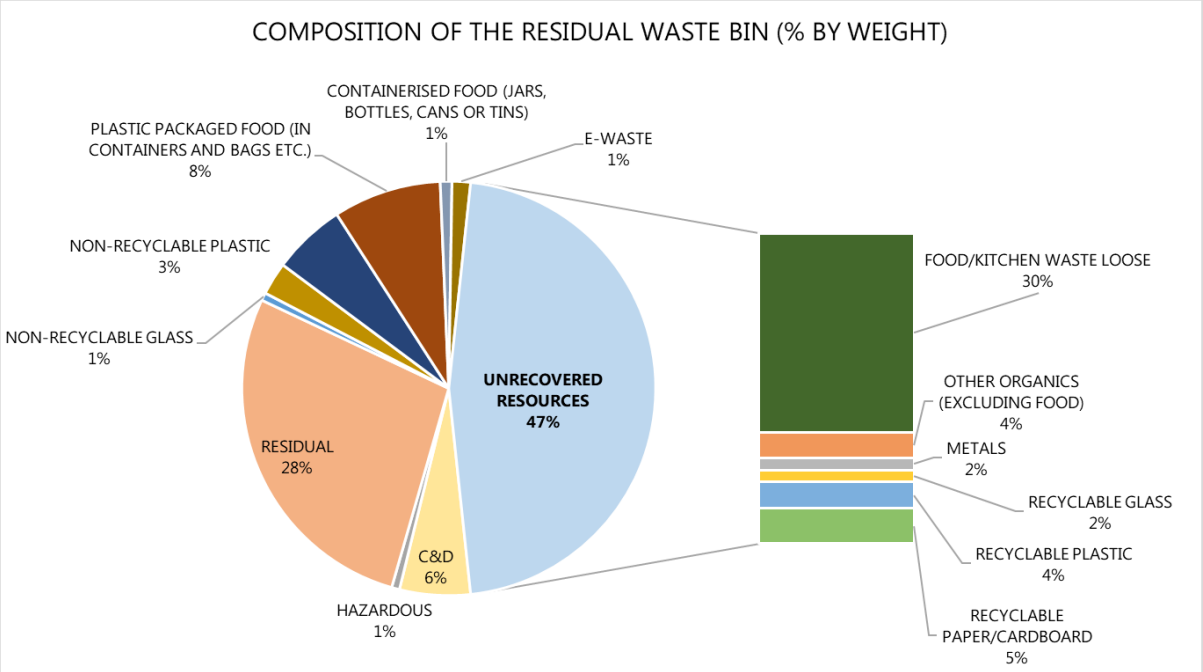


Figure 2: Composition of the residual waste bins across all audited households (% by weight)

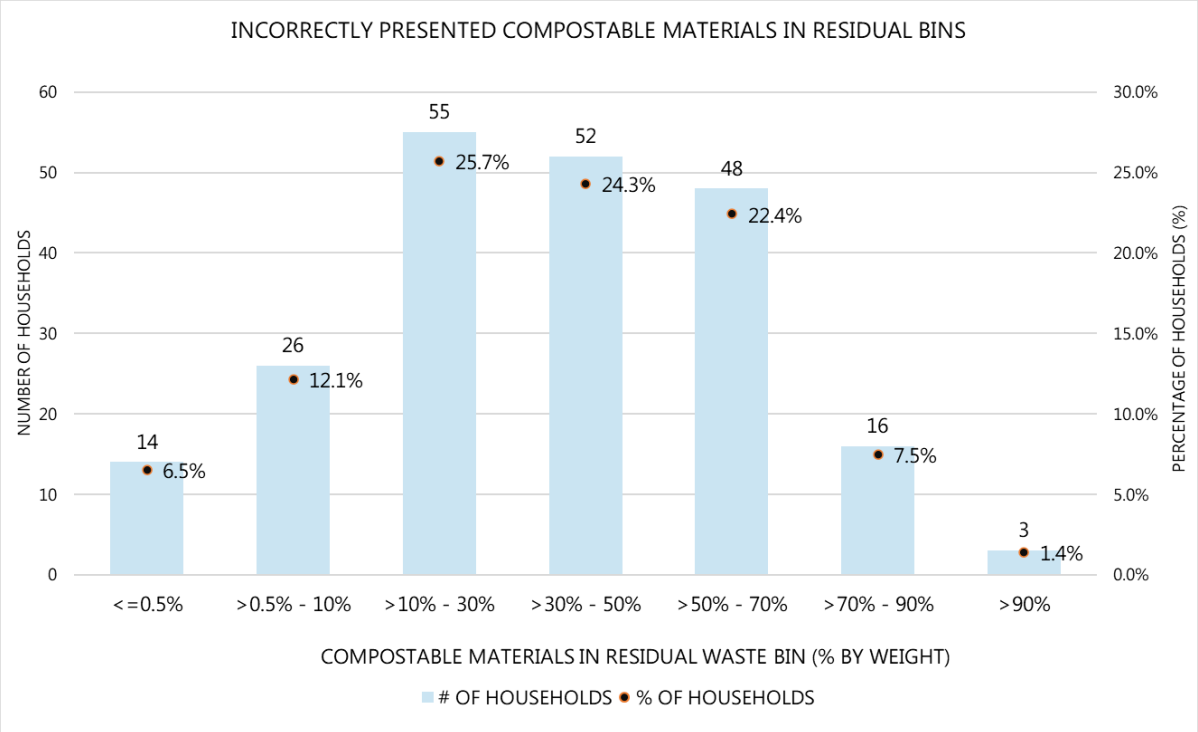


Figure 3: Distribution of the range of compostable material content in residual waste bins (% by weight) of all households audited

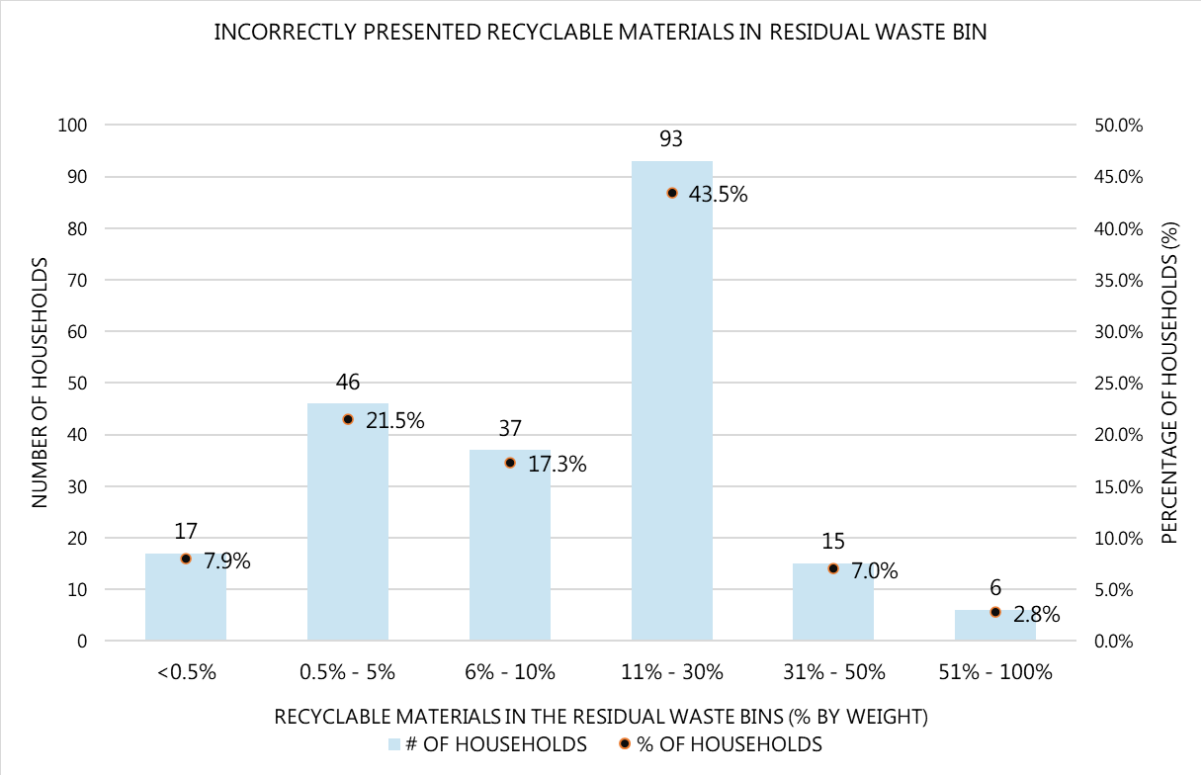


Figure 4: Distribution of the range of recyclable material content in residual waste bins (% by weight) of all households audited

Comingled recycling bins

The comingled recycling bins comprised of (Figure 5):

- paper/cardboard (45.4 per cent),
- recyclable glass (31.6 per cent),
- recyclable plastics (9.1 per cent) and,
- metals (3.7 per cent),
- contamination (10.1 per cent).

A contamination rate of 10 per cent is consistent with previous aggregated audits in the same Council. Contaminating the comingled recycling bins is problematic and leads to high costs for material recovery facilities. It also lowers the value of materials that are collected for recycling.

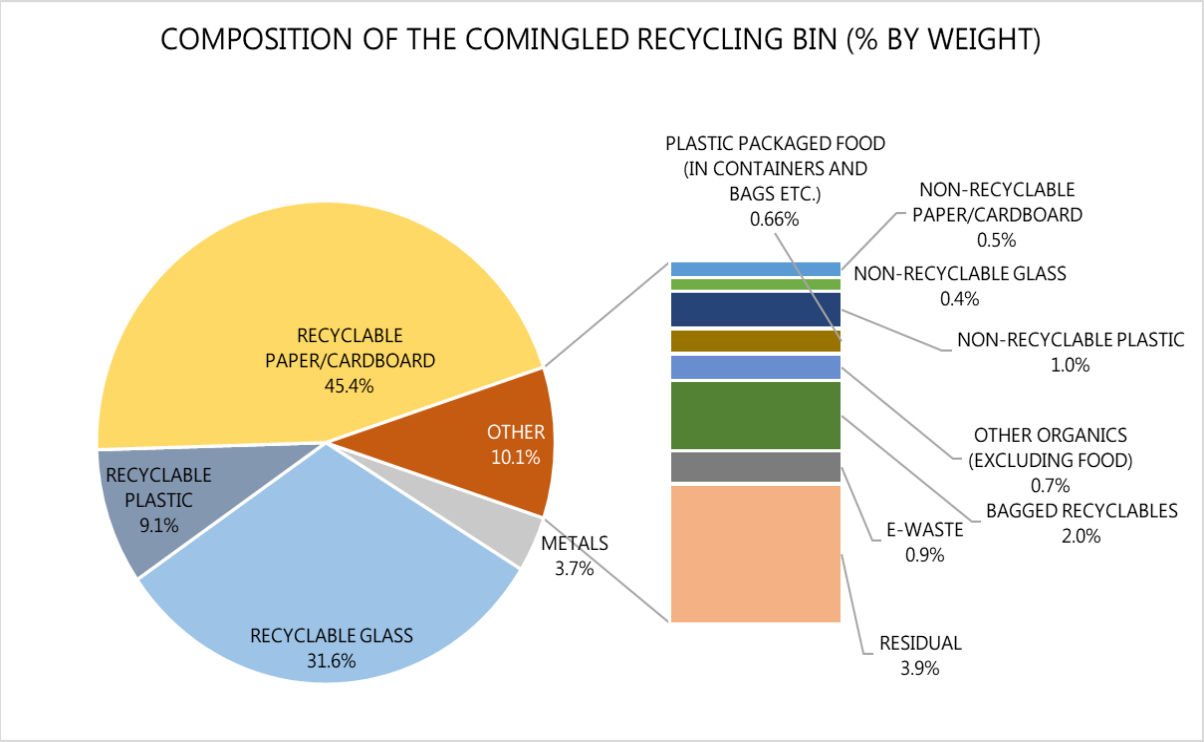


Figure 5: Composition of the comingled recycling bin across all audited households (% by weight)

Data was analysed to see if people are placing comingled recyclables into residual waste bins because they do not have enough room in their comingled recycling bins. Figure 6 shows the distribution of the fullness range of comingled recycling bins (0 to 100 per cent full) on the X-axis and the kilograms recyclable material in the corresponding residual waste bin on the Y-axis.

Finding: Households with more recyclable materials in their residual waste bins do not necessarily have overfull comingled recycling bins!

There is no correlation to show that households who have very full comingled recycling bins are more likely to have more recyclable materials in their residual waste bins (Figure 6). Bin space does not seem to be the issue contributing to households not separating their recyclables properly. Interestingly, households placing more recyclable material in their residual waste bins tended to have heavier (but not fuller) comingled recycling bins. Further correlation tests showed that the correlation between fullness of comingled recycling bins and weight of recyclable materials in residual waste bins is very small (correlation coefficient=0.08) and not significant (*p*-value=0.26).

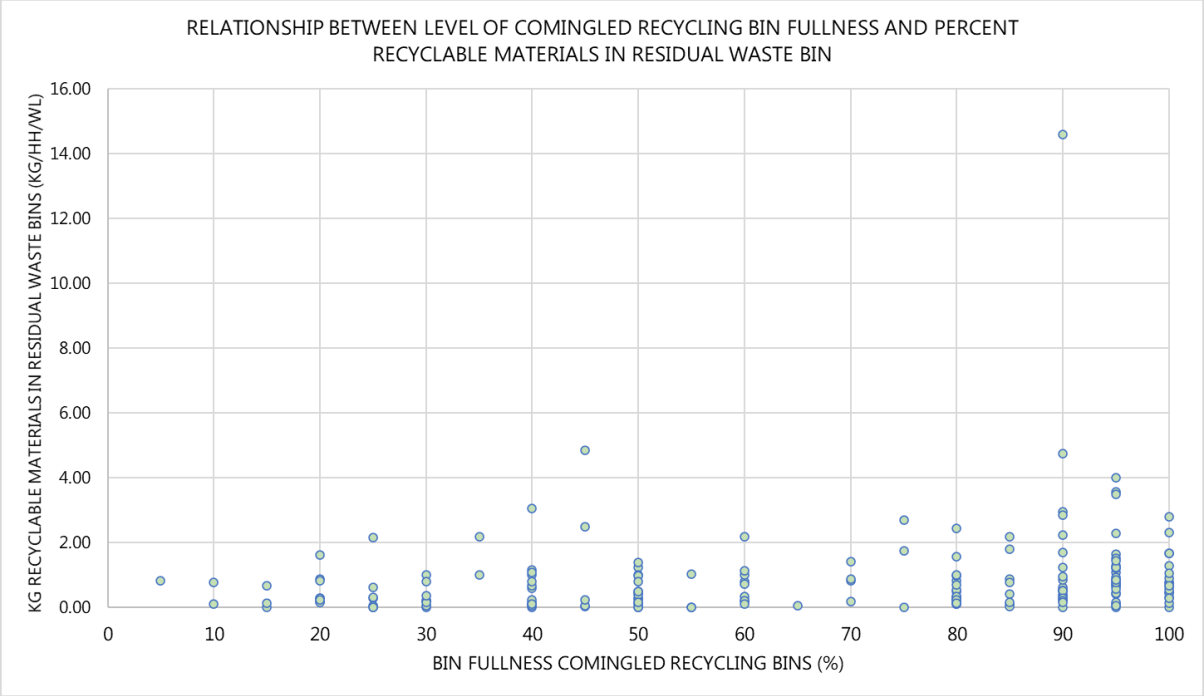


Figure 6: Relationship between the bin fullness of comingled recycling bins and the amount of recyclable materials in the matching residual waste bin (175 bins of each stream)

Organics bins

Figure 7 depicts the materials by weight that made up the organics bin.

- Food organics (excluding packaged and containerised food) made up only a small portion of the organics bin - 9.6 per cent by weight. This included food in compostable starch bags (8.1 per cent) and loose food (1.5 per cent).
- Most of the organics bins (85.7 per cent) was made up of garden organics (lawn clippings, leaves, prunings, branches).
- Contamination was high at 4.1 per cent by weight (including organics in non-compostable packaging). This is undesirable and is much higher than the South Australian metropolitan average of approximately 2 per cent. In the previous audit undertaken in Burnside in 2019, contamination in the organics bin was 1 per cent. Note that commercial composters prefer contamination of less than 1 per cent. Contaminates such as soft plastics (plastic film, loose plastic bags) weigh little but can have significant impacts on processing and sorting activities at the composting facilities.

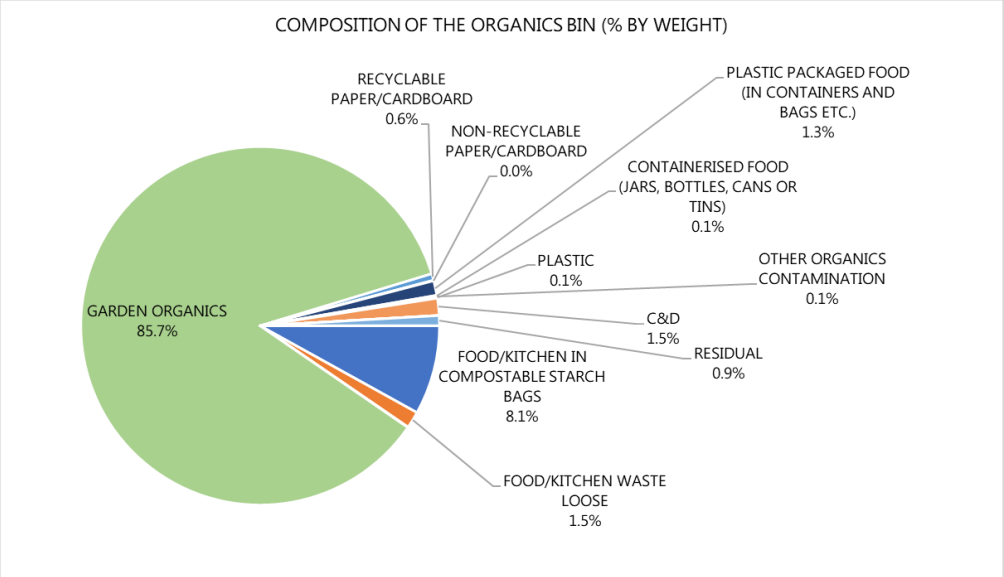


Figure 7: Composition of the organics bin across all audited households (% by weight)

2.3 How much waste are households diverting from landfill?

On average, households divert 59 per cent (by weight) from landfill[8] (see Figure 8). In the previous Burnside aggregated audit, the overall landfill diversion was 65 per cent. The green waste generation was significantly higher, as the previous audit was done in springtime in October/November. This leads to a greater diversion.

Performance varies substantially across households (see Table 3 and Figure 9):

- 40 per cent of households are high performers (with diversion levels above 70 per cent).
- 9 per cent of households are poor performers (with diversion levels lower than 30 per cent).
- The remainder (51 per cent of households) have diversion levels between >30 and 70 per cent.

	Landfill diversion range (%)	*# of households*	*% of households*
Poor performers	<=10%	2	1.1%
	11% - 20%	4	2.3%
	21% - 30%	10	5.7%
	31% - 40%	21	12.0%
	41% - 50%	21	12.0%
	51% - 60%	27	15.4%
	61% - 70%	20	11.4%
High performers	71% - 80%	21	12.0%
	81% - 90%	21	12.0%
	>90%	28	16.0%

Table 3: Landfill diversion (%) across households (with 3 matched bins)

[8] This diversion rate from landfill represents the household bin diversion only (prior to processing) and is based on weight and available presentation data. It does not consider the levels of contamination that were found (outlined in detail below) in the comingled and organics recycling bins, which upon passing through a materials recovery facility or compost facility, end up in landfill.

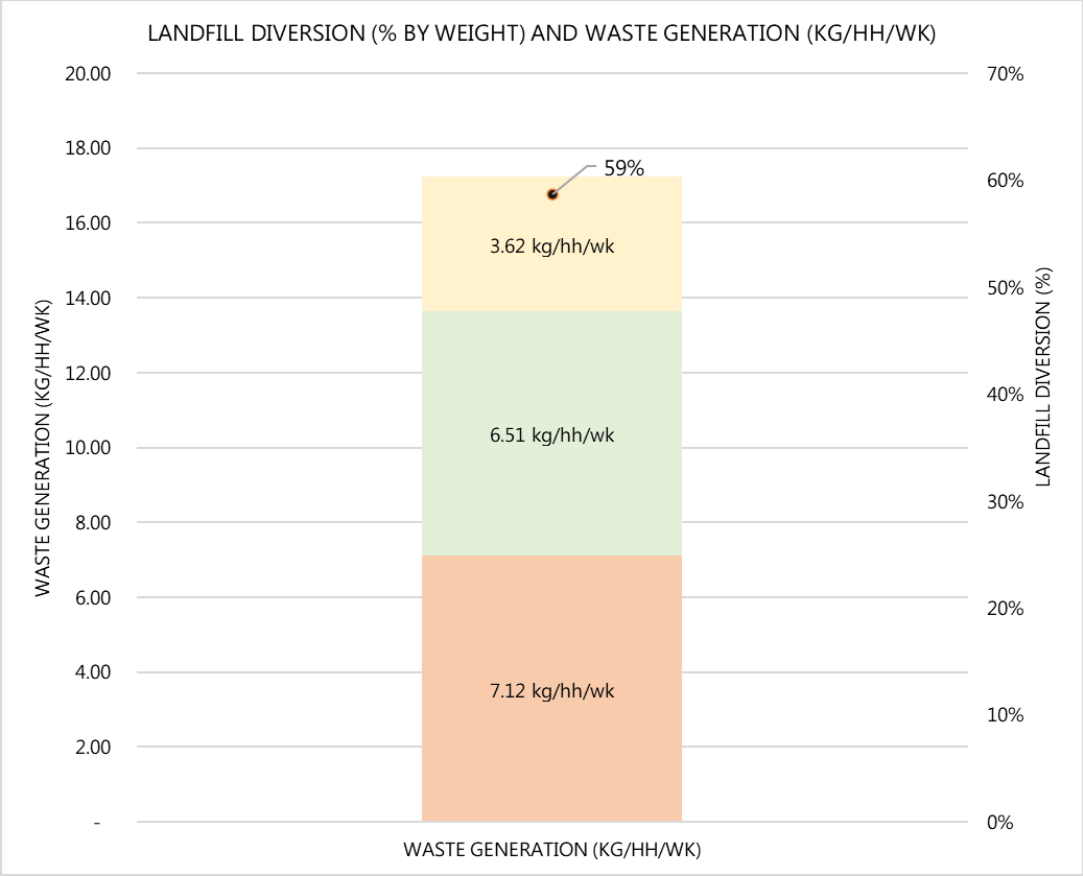


Figure 8: Landfill diversion and weekly waste generation of the 3 waste streams per household (across households with 3 matched bins), adjusted for collection frequency and presentation rates.

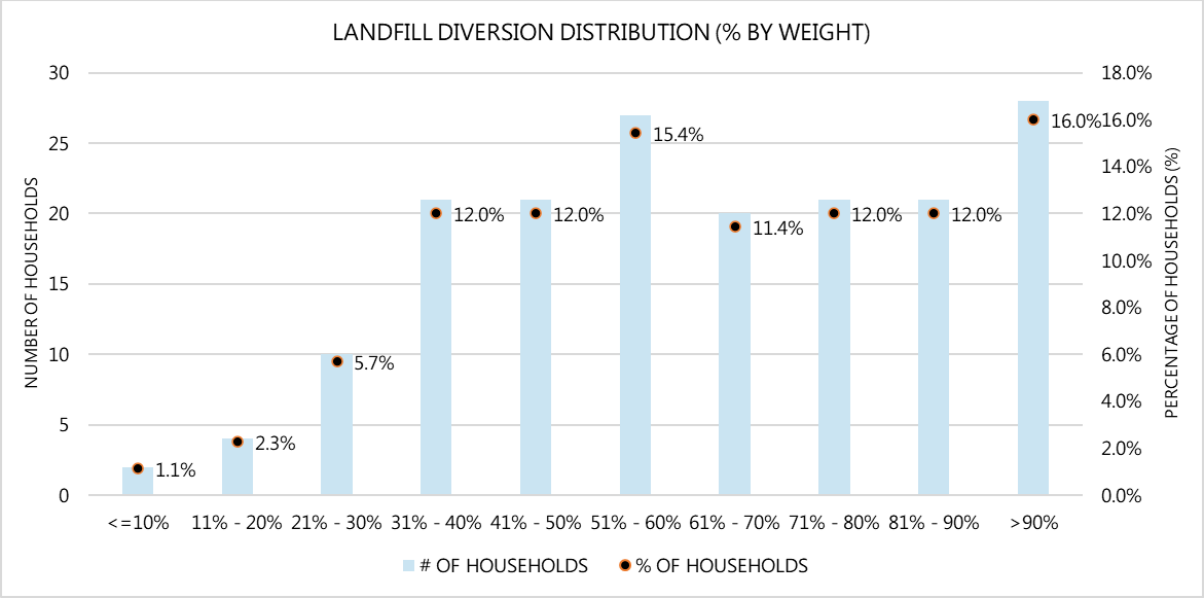


Figure 9: Distribution of individual household landfill diversion (% by weight), based on 3 matched bins. Note that this does not exclude the contamination found in the comingled recycling and organics bins.

2.4 How efficient are households at separating different recyclables?

Material separation efficiency is the proportion of a material by weight that is disposed into the correct bin out of the total amount of that material discarded in all the bins. It provides an insight into how well residents are separating recyclable materials into the correct bin. It is calculated by determining the weight of material in the correct bin divided by the total weight across all 3 bins.

Figure 10 shows the average material separation efficiencies for households with three matched bins. Figure 11 compares material separation efficiencies between this audit and a previous audit in the City of Burnside in 2019. Caution should be taken when comparing audit results between the two periods given differences in sampling:

- The 2019 audit was an aggregated audit, sampling from 100 households in spring October/ November.
- The 2019 audit includes both single- and multi-unit dwellings (whereas this audit excluded multi-unit dwellings).

Residents are performing well in relation to garden organics, glass, and paper/cardboard. They are recycling most garden organics (95 per cent in 2021), glass (90 per cent), and paper/cardboard (83 per cent) that they dispose at kerbside. Metals has a higher diversion rate than the last audit (52 per cent, up from 45 per cent in 2019). Only 22 per cent of food organics are being discarded into organics bins. The food waste efficiency is higher than the last audit in 2019 (13 per cent efficiency)[9]. This difference in food efficiency rates may be partly driven by the difference in sampling. As noted above, this audit included only single-unit dwellings, which typically have higher food efficiency rates than multi-unit dwellings.

[9] The correct bin to dispose of food waste is the organics bin. Food waste efficiencies include loose food, food in compostable bags, food wrapped in newspaper, and packaged food (i.e. containerised food and food in plastic bags). If packaged food is excluded (given any non-compostable containers/bags surrounding the food is a contaminant), then the food waste efficiency for 2021 audit reduces to 19%, and the food waste efficiency for the 2019 audit reduces to 11%.

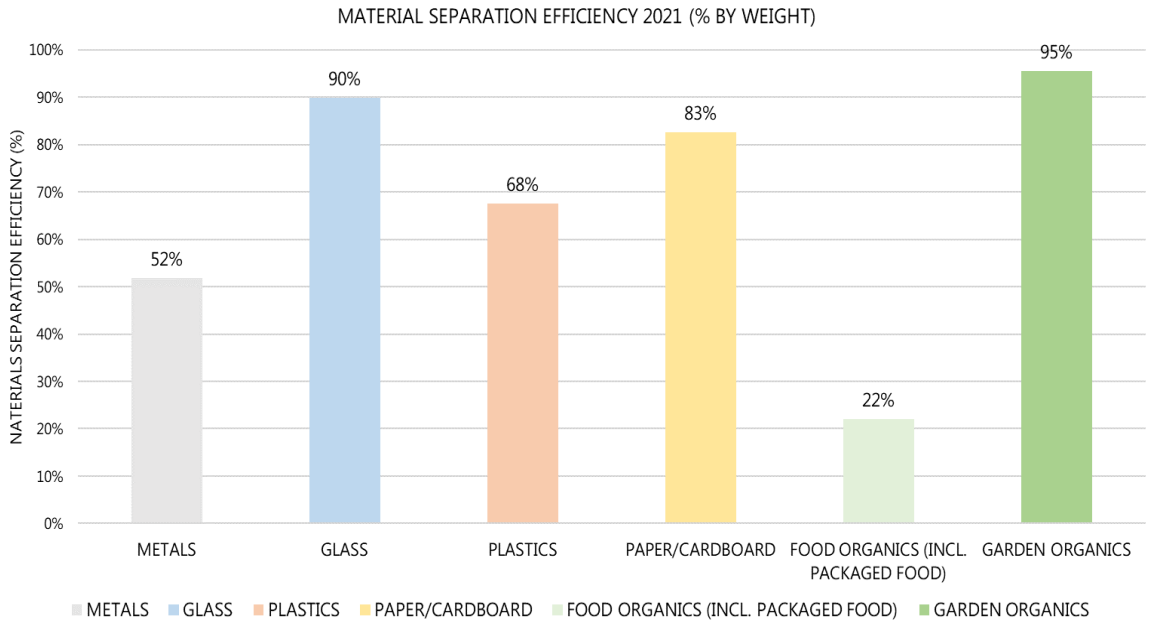


Figure 10: Material separation efficiency across households with 3 matched bins

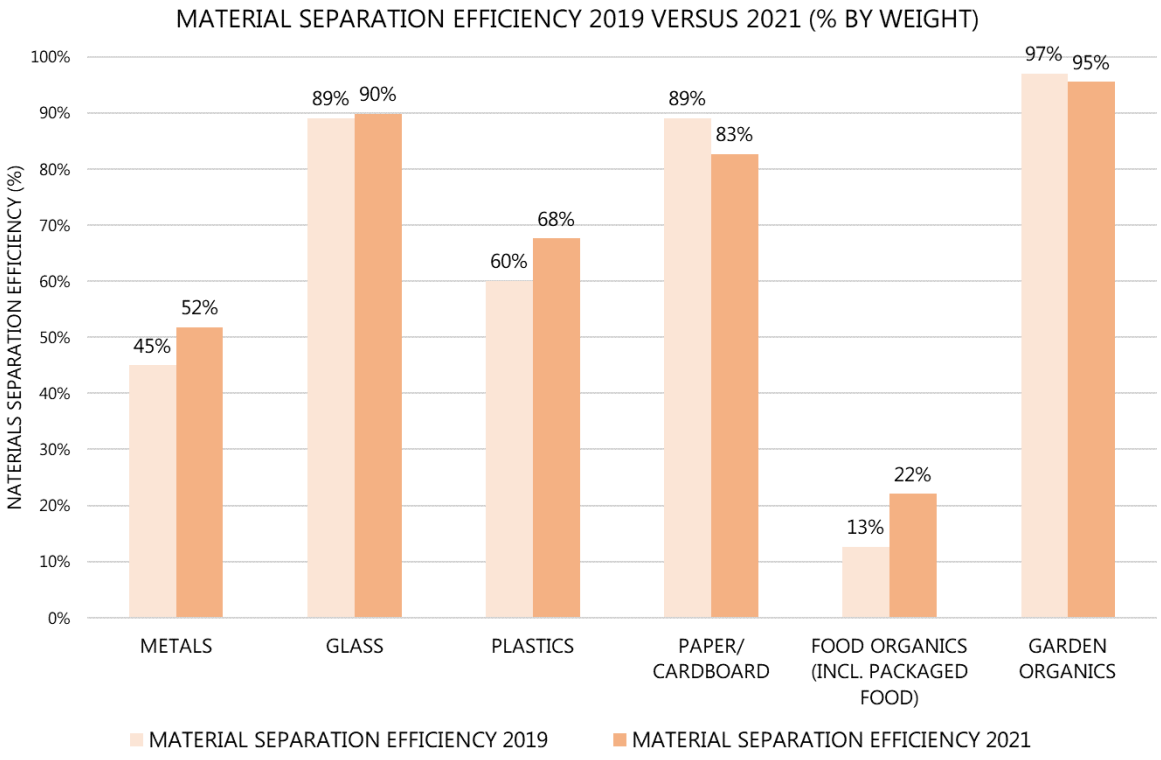


Figure 11: Comparing material separation efficiencies between this audit and the 2019 audit

3. Results – a deep dive into food waste behaviours

3. A deep dive into food waste behaviours

Section 2 identified that only 22 per cent of food waste disposed through kerbside systems is sorted into organics bins. The remaining 78 per cent is disposed to landfill. This section provides a deep dive into household food waste behaviours. Composting food waste via the kerbside organics service, rather than landfilling it can provide numerous environmental and economic benefits.

Project partners are keen to understand not only the quantities (volume and weight) of the opportunity for diverting more food waste from landfill, but also exactly what type and how food is being discarded. To achieve this, the audit involved first separating food waste into its bin disposal method (loose, plastic bagged, compostable bags, still packaged). Food waste was then separated into 10 distinct categories (meat, dairy, fruit, breads etc.). Finally, the food waste was assessed to see what percentage of the food waste could have been eaten at some stage.

3.1 How much and what types of food waste do households discard[10]?

On average, households discarded 3.6 kg of food waste per week[11] across their kerbside bins. Food waste disposal levels vary a lot across households[12] (see Figure 12):

- Close to a quarter of households (23.4 per cent) are discarding less than 1 kg of food waste per week across their kerbside bins.
- About half of households are discarding between 1 and 4.9 kg of food waste per week across their kerbside bins.
- Nearly a quarter (23.4 per cent) of households are discarding large amount of food waste (>5 kg per week). This is well above the average food waste disposal of 3.6 kg per household per week across their kerbside bins.

The distribution of food waste disposal is calculated from the matched residual waste, organics, and comingled recycling bins (175 bins from each stream).

The main types of food households are wasting (Figure 13) include:

- Vegetables (21 per cent by weight)
- Fruit (20 per cent by weight)

[10] Food waste disposal is based solely on the quantity of food discarded through the kerbside systems.

[11] The food waste generation rate referred to throughout this report (at 3.6 kg/hh/wk) is the average across all bins audited. We also calculated the food waste generation rate for households where we were able to match all three bins (a subset of all bins audited). The average food generation rate for the latter group was higher at 3.8 kg/hh/wk. Statistical tests undertaken by the University of Adelaide found that the difference in these generation rates was not statistically significant.

[12] Households vary by size. There is need for stronger data to ascertain the food waste disposal across households of similar sizes.

- Meat, poultry and fish (9 per cent by weight)
- Bread (8 per cent by weight)
- Some food quantities (39 per cent by weight) were not discernible given they were highly mixed and/or degraded
- Food waste identified as takeaway food was the least common discarded food type identified (less than 1 per cent). It is likely some of this type of food waste is included in the not discernible food waste category.

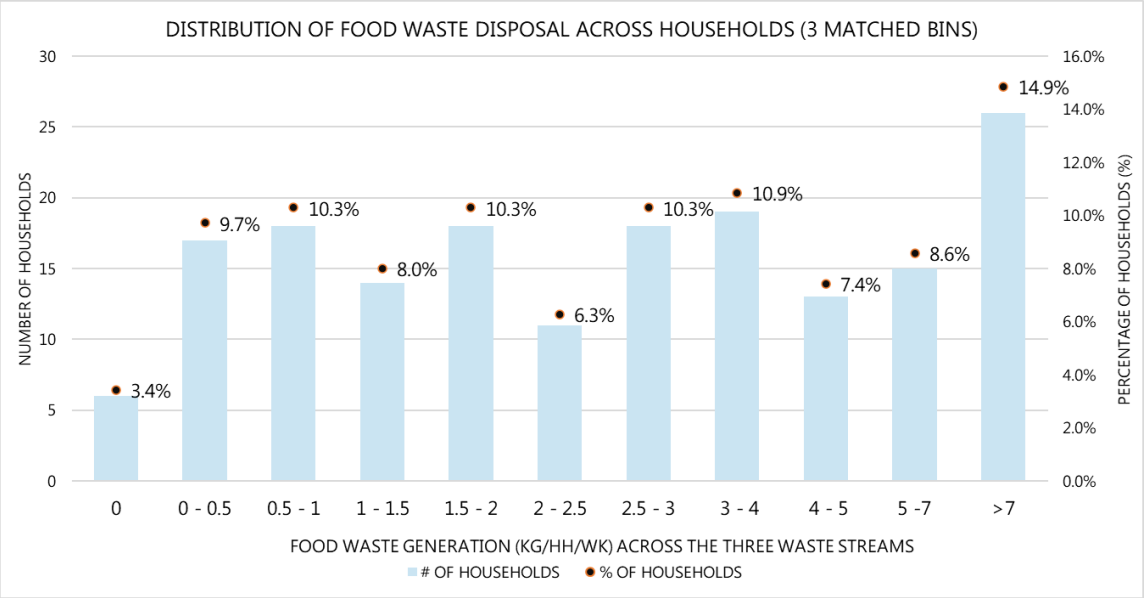


Figure 12: Distribution of food waste disposal across households with 3 matched bins

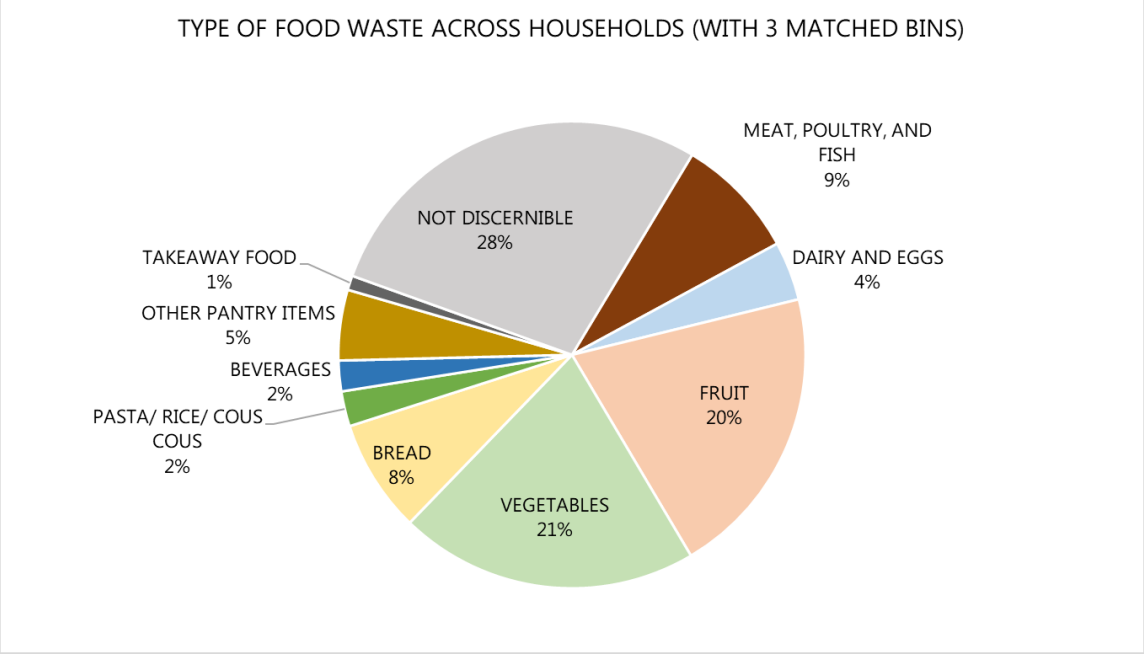


Figure 13: Type of food waste across households with 3 matched bins

3.2 How do the results compare to national food waste estimates?

Table 4 compares food waste disposal between the City of Burnside and national estimates. Bin audit data from the ENGAGE program of the Fight Food Waste Cooperative Research Centre (FFW CRC) revealed that Australian households generate 4.22 kg of food per week. This included:

- 1.78 kg of food in the residual waste bin (estimated through bin audits across several States and Territories[13])
- the balance (2.44 kg) managed through other food disposal methods (e.g. home composting, feeding to pets). This was estimated by households provided with questionnaires about their food disposal methods. Note that none of the households in the study had access to council food organics services and hence no food waste was placed by residents in kerbside green bins.

This compares to City of Burnside disposal of 3.6 kg of food waste per week per household (the average amount disposed by households across 3-bin kerbside system). However, this audit did not include food waste discarded via other methods, such as home composting and feeding pets.

	Burnside food waste (disposed via the 3-bin kerbside system)	National food waste
	kg/hh/wk	*kg/hh/wk*
Food waste estimate	3.6	4.2

Table 4: Comparison of food waste discarded in Burnside and nationally

3.3 How did food waste disposal compare to the previous audit in Burnside?

These audit results are higher than the previous audit conducted in the City of Burnside in 2019. This may be partially attributed to our audit methodology, which did not include multi-unit dwellings (MUDs) in the audit. Medium and high density dwellings represent 34 per cent[14] of the Council and their behaviour was not captured in this audit. This would have affected the results, as single-unit dwellings (SUDs) are more likely to attract families and prospective families, and usually generate more food waste than MUDs.

[13] The research did not include South Australian households.

[14] Dwelling type | City of Burnside | Community profile. (2021). (https://profile.id.com.au/burnside/dwellings)

3.4 How much discarded food could have been eaten?

The auditor also estimated the amount of the food that was inedible compared to edible.

Edible food for this purpose was defined as all food and food components that were intended to be eaten. Inedible food includes food deemed unsuitable for consumption. It includes items like eggshells. Some food was presented in its packaging (typically lightweight plastic). In these cases, the weight of the packaging was included in estimates of the inedible volumes.

Table 5 outlines the findings from the assessment and shows that an estimated 64 per cent of food disposed of per household could have been eaten. Fruit, meat, poultry and fish were the only categories where the edible component was below 60 per cent edible, all other categories were 60 per cent edible or above. Figure 14 shows the split between edible and inedible food in both residual waste and organics bins and the disposal method for edible and inedible food (kg/hh/wk).

Food waste type	Edible	Inedible	Total	% of total food waste edible
	kg/hh/wk	*kg/hh/wk*	*kg/hh/wk*	*%*
Meat, poultry, and fish	0.17	0.14	0.31	55%
Dairy and eggs	0.12	0.04	0.15	75%
Fruit	0.32	0.42	0.74	43%
Vegetables	0.48	0.25	0.73	66%
Bread	0.29	0.00	0.29	99%
Pasta/ rice/ cous cous	0.08	0.00	0.09	95%
Beverages	0.07	0.01	0.08	88%
Other pantry items	0.12	0.06	0.18	67%
Takeaway food	0.03	0.00	0.03	87%
Not discernible[15]	0.58	0.37	0.95	61%
Total	**2.27**	**1.30**	**3.56**	**64%**

Table 5: Total amount of food that was edible and inedible from kerbside bins (average across all audited kerbside bins)

[15] The 'not discernible' category included different types of food that was placed together in a bag, so it was not possible to break it down to the individual food type, e.g. meat vs. vegetables in a curry. The contents in the bag were clearly visible and the physical auditor was able to deem them edible or inedible.

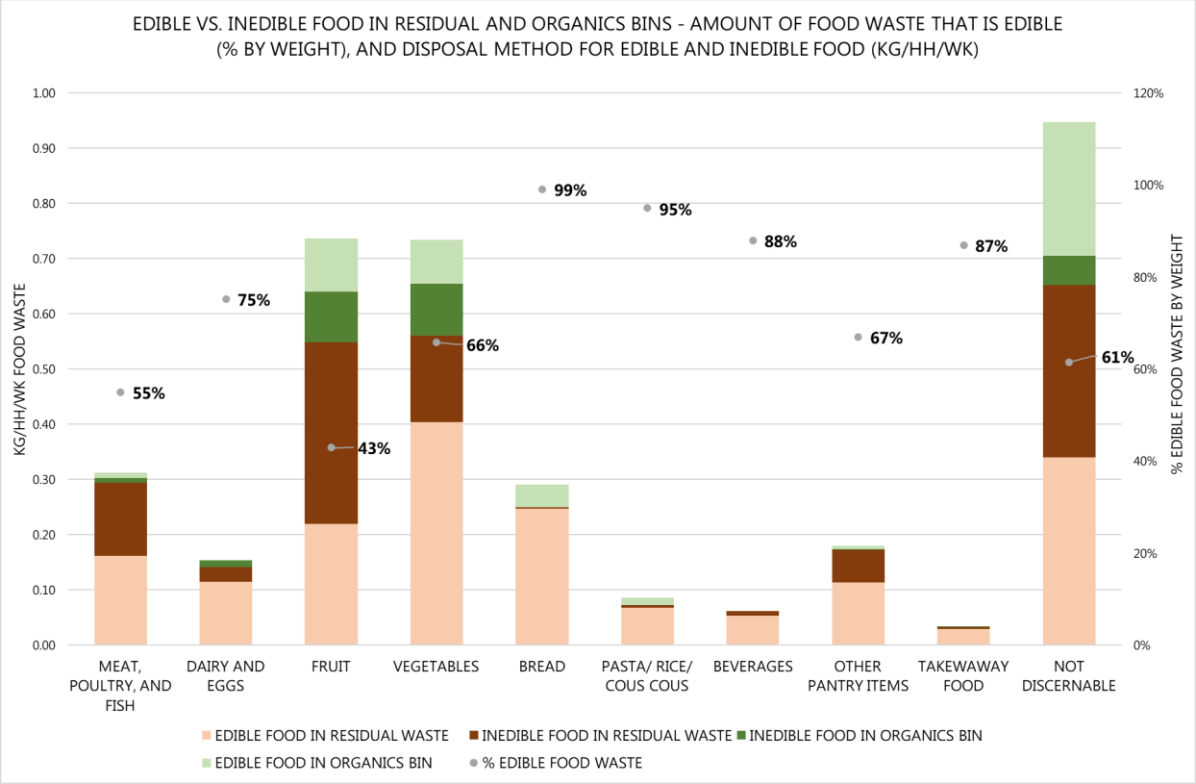


Figure 14: Edible vs. inedible food in residual waste and organics bins - amount of food waste that is edible (% by weight), and disposal method for edible and inedible food (kg/hh/wk)

3.5 How good are households at sorting their food waste?

The average food waste efficiency rate was 22 per cent. However, this varies a lot across households (see Figure 15):

- Close to half of households (47 per cent) are disposing of all their food waste in the residual waste bin (0 per cent food efficiency rate).
- Almost 3 per cent of households did not dispose of any food waste in the kerbside residual waste or organics bin. We suspect these households are managing their food waste using other systems, such as home composting.
- About a quarter (24 per cent) of households are recycling most of their food waste (>80 per cent by weight).

The distribution of food waste efficiency is calculated from the matched residual waste and organics bins (208 bins each stream).

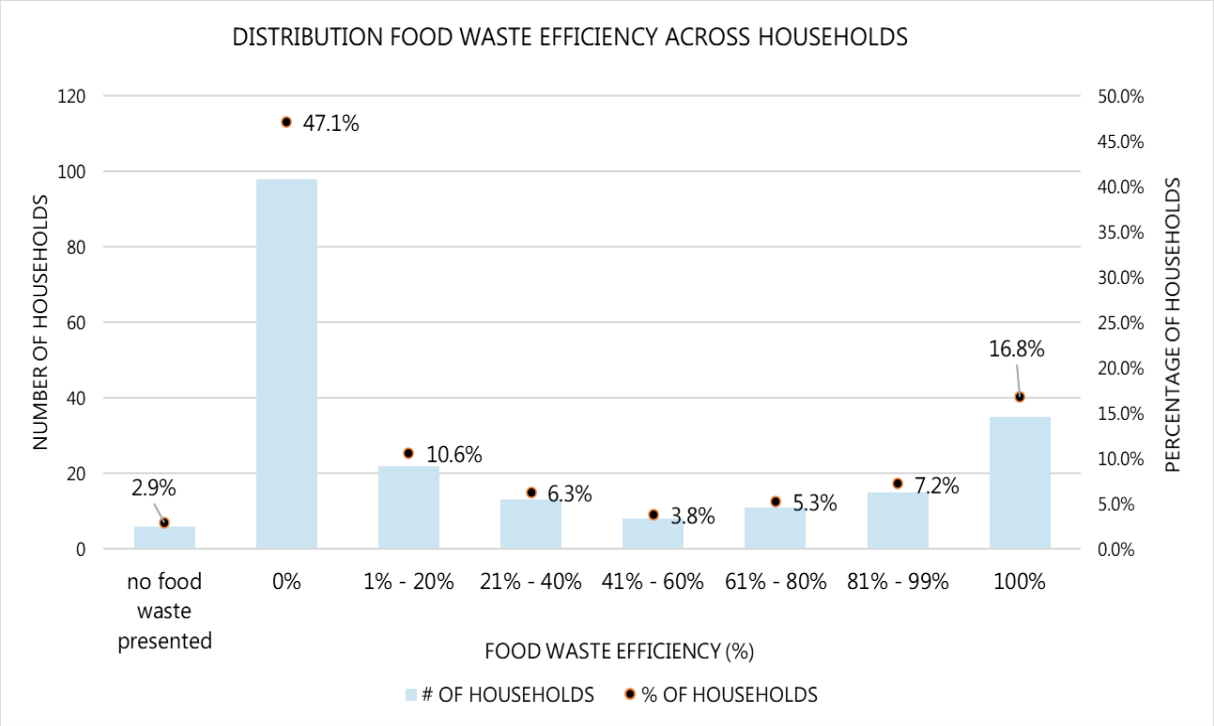


Figure 15: Food waste efficiency across households with matched residual waste and organics bins (208 bins each stream)

3.6 How is food waste being presented in the bins?

Food waste was separated into 4 different presentation categories: loose food, food in compostable bags, food in plastic packaging, and food in containers (e.g. tins, jars). Table 6 below outlines the method of food waste disposal across all audited kerbside bins. These results have been adjusted to consider presentation rates and are presented in 'kilograms per household per week'.

Types	Residual waste	Organics	Comingled	Total
	kg/hh/wk	*kg/hh/wk*	*kg/hh/wk*	*kg/hh/wk*
Food in compostable bags	0.01	0.55	-	**0.6**
Loose food	2.12	0.10	-	**2.2**
Plastic packaged food	0.60	0.09	0.02	**0.7**
Food in containers (e.g. jars/tins)	0.06	0.01	-	**0.1**
Total	**2.79**	**0.75**	**0.02**	**3.6**

Table 6: Summary of the method of disposal for food waste in the kerbside bins of households (all bins)

Insight 1: Almost two-thirds (63 per cent) of food waste was loose and more than 95 per cent of it was in the residual waste bin.

Insight 2: Almost all food waste that was disposed in compostable bags was correctly placed in the organics bins and therefore diverted from landfill.

3.7 What proportion of households are using compostable bags? Are they using them correctly?

The number of compostable bags containing separated food/organics were recorded during the audit. This reveals whether residents are using compostable bags to dispose of food/organics and whether they place it in the correct bin.

The key findings from the analysis were:

- 36 per cent of households with matched residual waste and organics bins (208 households total) use compostable bags (Figure 16).
- Of the households that recycle their food waste, 81.5 per cent use compostable bags (hence this is the preferred method by households).
- 69 per cent of households with 100 per cent food waste efficiency use compostable bags.
- Households that use compostable bags, on average, use 1.5 compostable bags per week.
- Most households (98.5 per cent) that use compostable bags place them correctly in the organics recycling bin.

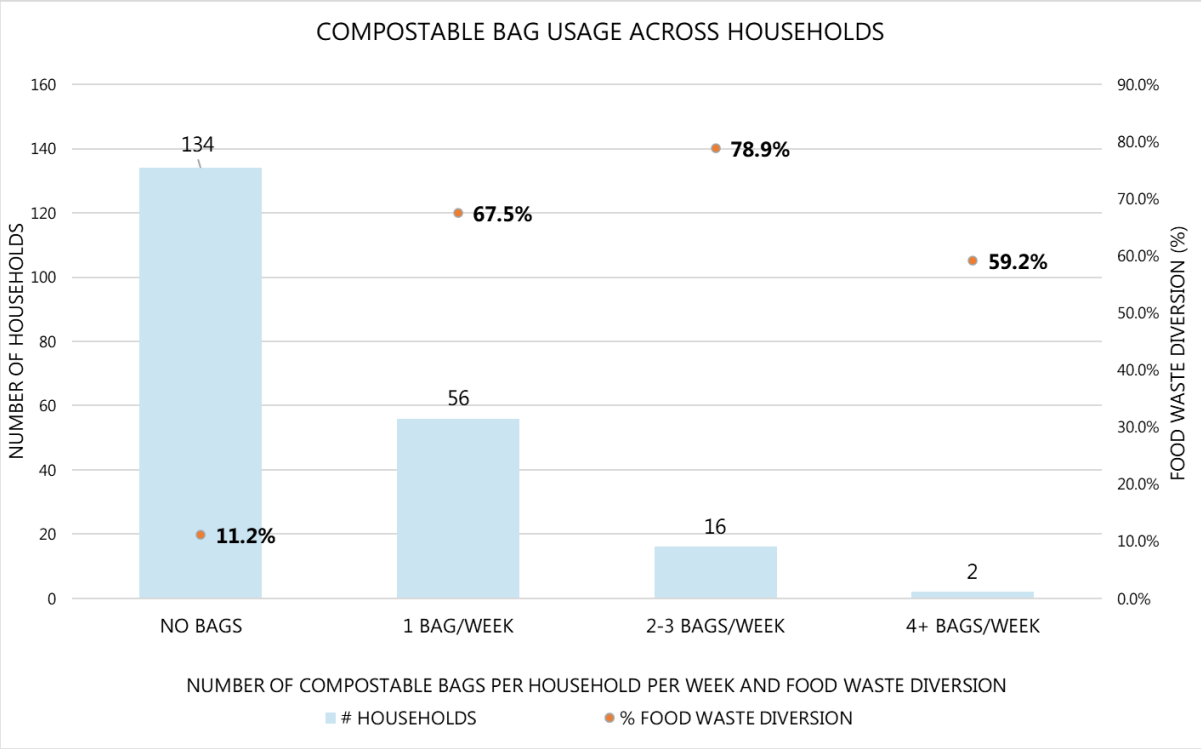


Figure 16: Number of compostable bags per household per week across households with matched residual waste and organics bins and their average food waste efficiency

Insight: Households that have high food waste diversion levels are using compostable bags

- Households that don't use compostable bags (134 households) divert 11 per cent of their food waste on average. Many of these households are not diverting any food waste.
- Households that use between 1 and 3 compostable bags per week (72 households) divert on average 70 per cent of their food waste.
- Households that use 4 or more compostable bags per week divert on average almost 60 per cent of their food waste. [16]
- The insight is backed up by a correlation test that shows the correlation between food waste diversion and number of compostable bags per household per week across households is significant (*p*-value=0.02) but small (correlation coefficient=0.18). This indicates that the higher food waste diversion levels, the more compostable bags households use.

3.8 How efficiently are households separating the different types of food?

Food waste identified during the audit was also separated into food waste types. Table 7 provides a summary of discarded food waste by type, discarded into either the residual waste, organics recycling, or comingled bins and as a total.

Types	Residual waste	Organics	Comingled	Total	% of total food waste	% food waste efficiency
	kg/hh/wk	*kg/hh/wk*	*kg/hh/wk*	*kg/hh/wk*	*%*	*%*
Meat, poultry, and fish	0.29	0.02	0.00	0.31	8.8%	5.7%
Dairy and eggs	0.14	0.01	0.00	0.15	4.3%	8.5%
Fruit	0.55	0.19	0.00	0.74	20.7%	25.4%
Vegetables	0.56	0.17	0.00	0.73	20.6%	23.5%
Bread	0.25	0.04	0.00	0.29	8.2%	14.1%
Pasta/ rice/ cous cous	0.07	0.01	0.00	0.09	2.4%	15.6%
Beverages	0.06	-	0.02	0.08	2.2%	0.0%
Other pantry items	0.17	0.01	0.00	0.18	5.2%	4.0%
Takeaway food	0.03	0.00	0.00	0.03	1.0%	0.1%
Not discernible	0.65	0.30	0.00	0.95	26.7%	31.0%
Total	**2.79**	**0.75**	**0.02**	**3.56**	**100.0%**	

Table 7: Summary of the types of food waste discarded in kerbside bins (average across all audited households)

[16] The sample of households that use 4 or more bags is very small (only 2 households, or less than 1 per cent of the total sample), which is not reliable in determining average values across council.

Figure 17 below illustrates food waste diversion (%) by food waste type.

Figure 17: Food waste diversion by food type

3.9 How are differently performing households separating the various food types?

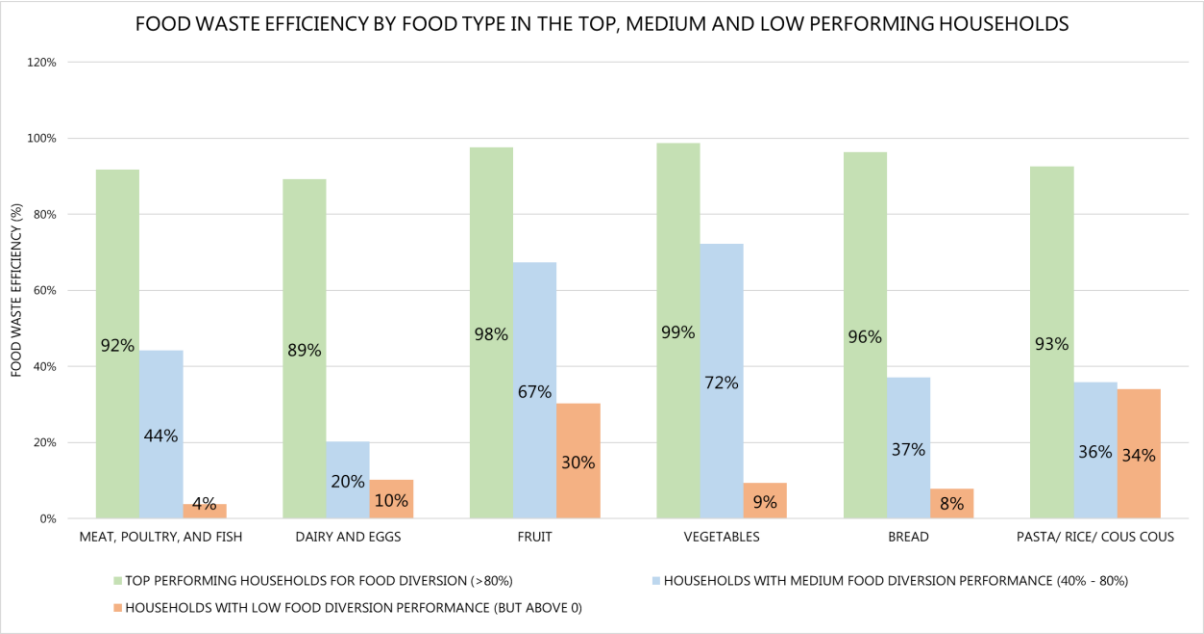


Figure 18: Food waste efficiency by food type in the top, medium and low performing households

It was found that (see Figure 18):

- The top performing households (who divert more than 80 per cent of their food waste) are efficiently separating all food types (e.g. meat, fruit and veg).

- The households with a medium food waste diversion (between 40 and 80 per cent of their food waste) are separating about two-thirds of their fruit and vegetables but are diverting less than half of their meat, poultry and fish, dairy and eggs, bread, and pasta.
- The low performing households which divert less than 40 per cent of their food waste (but still divert at least some of it), are separating some of their fruit and pasta. They divert less than 10 per cent of their meat, poultry and fish, dairy and eggs, vegetables, and bread.

Insight: Many households are not placing their meat, poultry, fish, dairy products and eggs into their organics bins. The same applies for beverages, takeaway food and other pantry items. However, these items together make up less than 14 per cent of the total food waste discarded.

3.10 Correlations between behaviours

Insight: there is a negative correlation between the amount of food waste disposed across 3 bins and food waste efficiency, although the correlation is not strong.

The hypothesis that households that sort their food waste are associated with lower food waste volume was tested. Though the correlation cannot be easily observed in the scatter plot (Figure 19), the correlation test shows that the correlation between the amount of food waste disposed across 3 bins and food waste efficiency is negative (correlation coefficient=-0.30) and significant (*p*-value=0.00). This indicates that the more households sort their food waste, the less food waste will be generated by households.

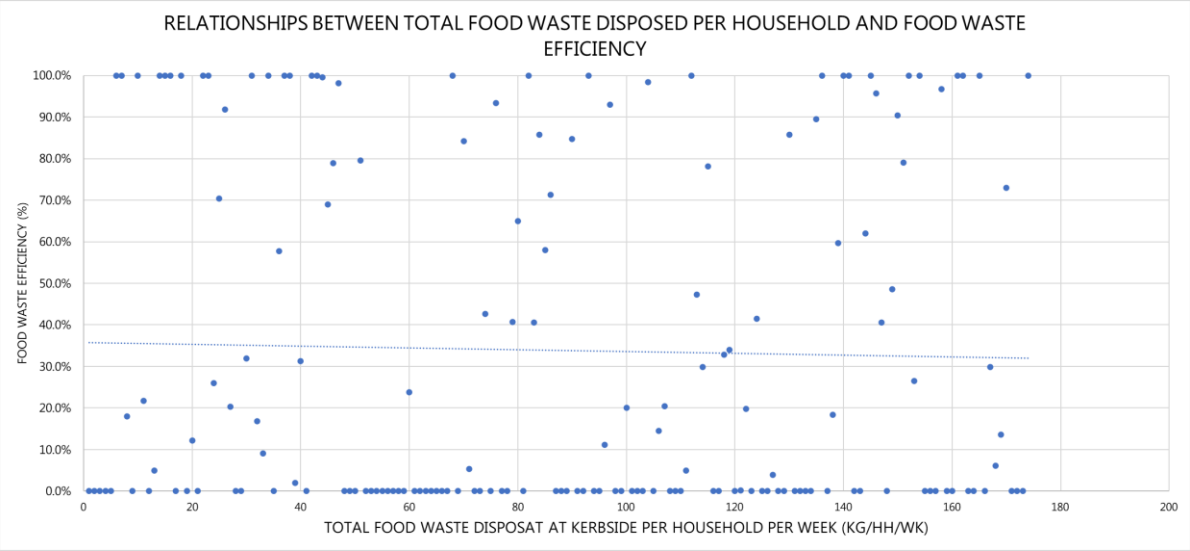


Figure 19: Relationship between total food waste generation and food waste efficiency

4. Results – contamination behaviours

4. Contamination behaviours

4.1 Contamination of residual waste bins

Average contamination in the residual waste bins audited was 2.1 per cent. This varies by household from 0 to 70 per cent. Figure 20 shows how contamination rates vary by households. The top 5 contaminants by weight are illustrated in Figure 21.

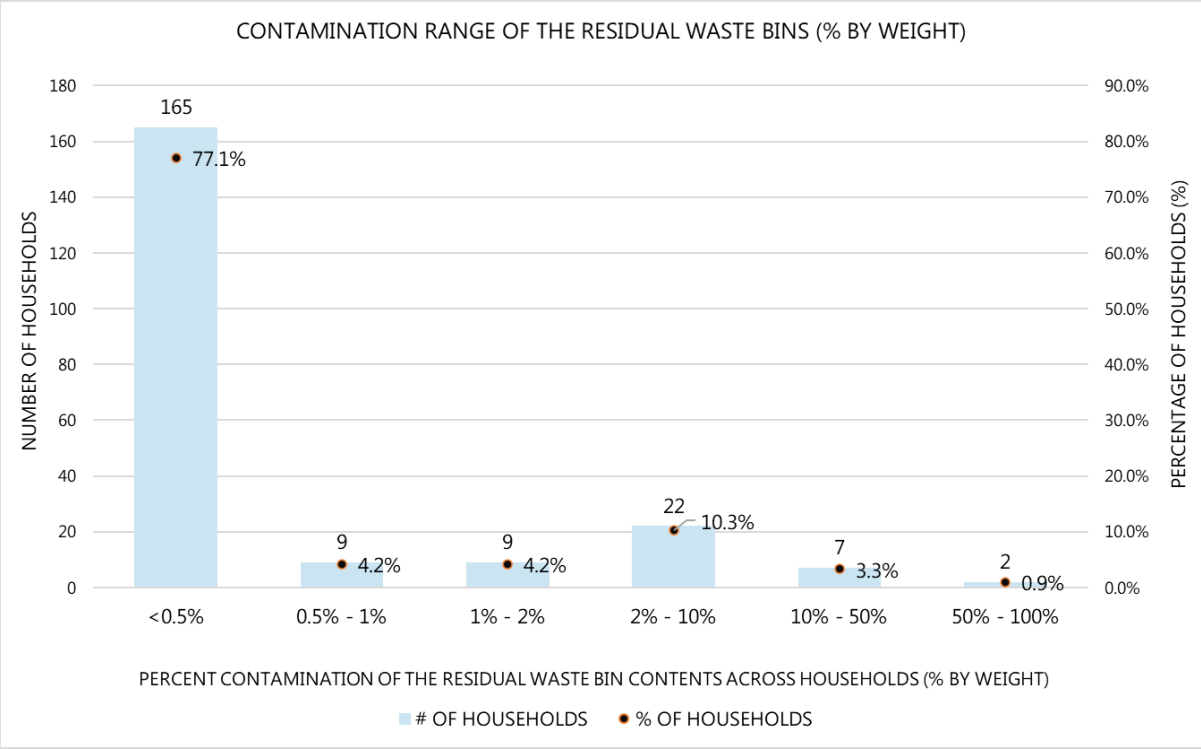


Figure 20: Distribution of the per cent contamination of the residual waste bin (all audited residual waste bins - 214)

Insight: Most households (77 per cent) have very low amounts of contamination in their residual waste bins (<0.5 per cent by weight).

The average contamination rate is largely driven by a small proportion of households who are grossly contaminating their bins.

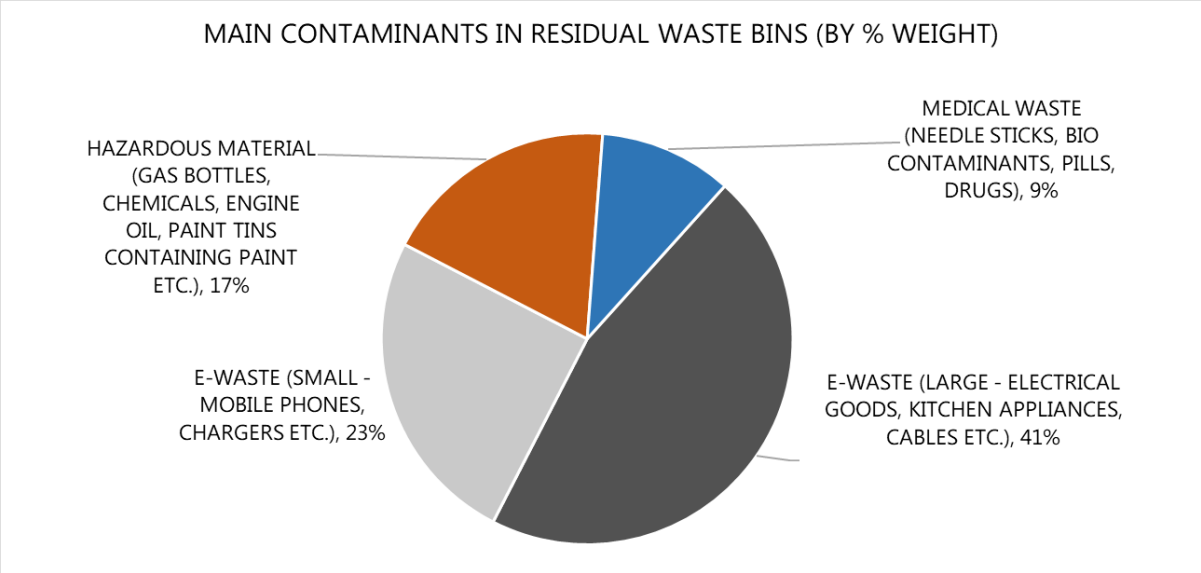


Figure 21: Main contaminants (% by weight) in the residual waste bins (all residual waste bins audited - 214)

4.2 Contamination of organics bins

Average contamination in the total organics bins audited was 4.1 per cent. This varies by household from 0 to 93 per cent. Figure 22 shows how contamination rates vary by households. The main contaminants by weight are illustrated in Figure 23, all of which are challenging for the commercial composters that process the material.

Contamination rates for organics bins are significantly above the state average of 2 per cent. Contamination remains a significant challenge within the kerbside collection system. C&D materials, plastic packaged food and residual waste are consistently in the top main contaminants, as illustrated in Figure 23.

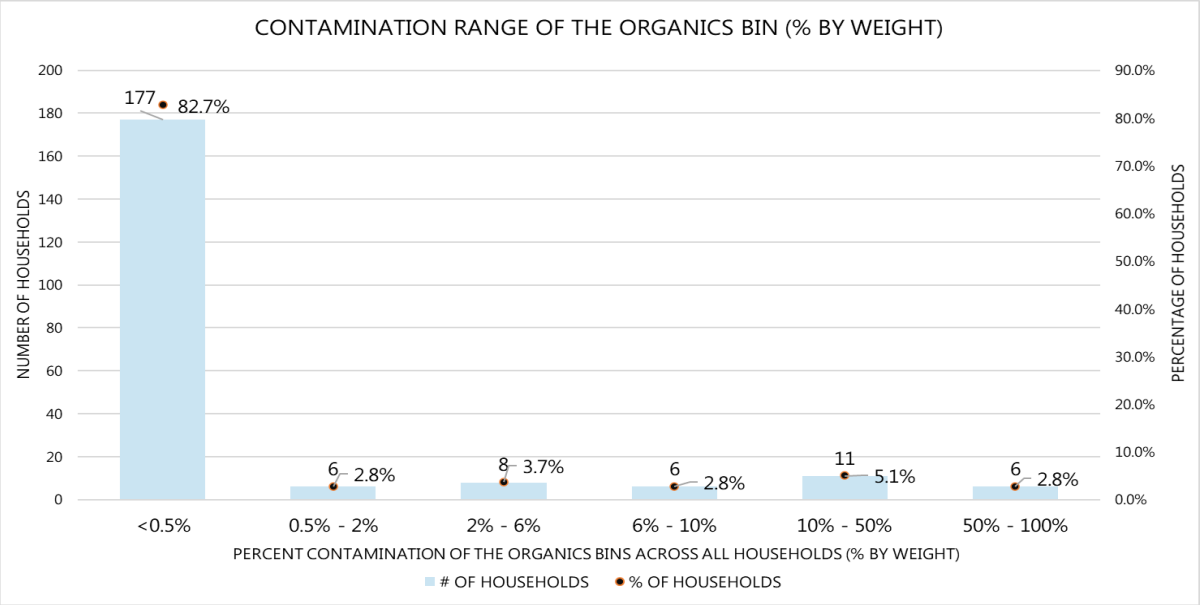


Figure 22: Distribution of the per cent contamination of the organics bin (all audited organics bins)

Insight: More than 80 per cent of households have very low levels of contamination (<0.5 per cent by weight).

The average contamination rate is largely driven by a small proportion of households who are grossly contaminating their bins.

Reducing contamination in both the organics recycling and comingled recycling streams should remain a high priority. This includes investigating additional ways of identifying and reporting contamination at a household level, using current (and future) technology available on collection vehicles.

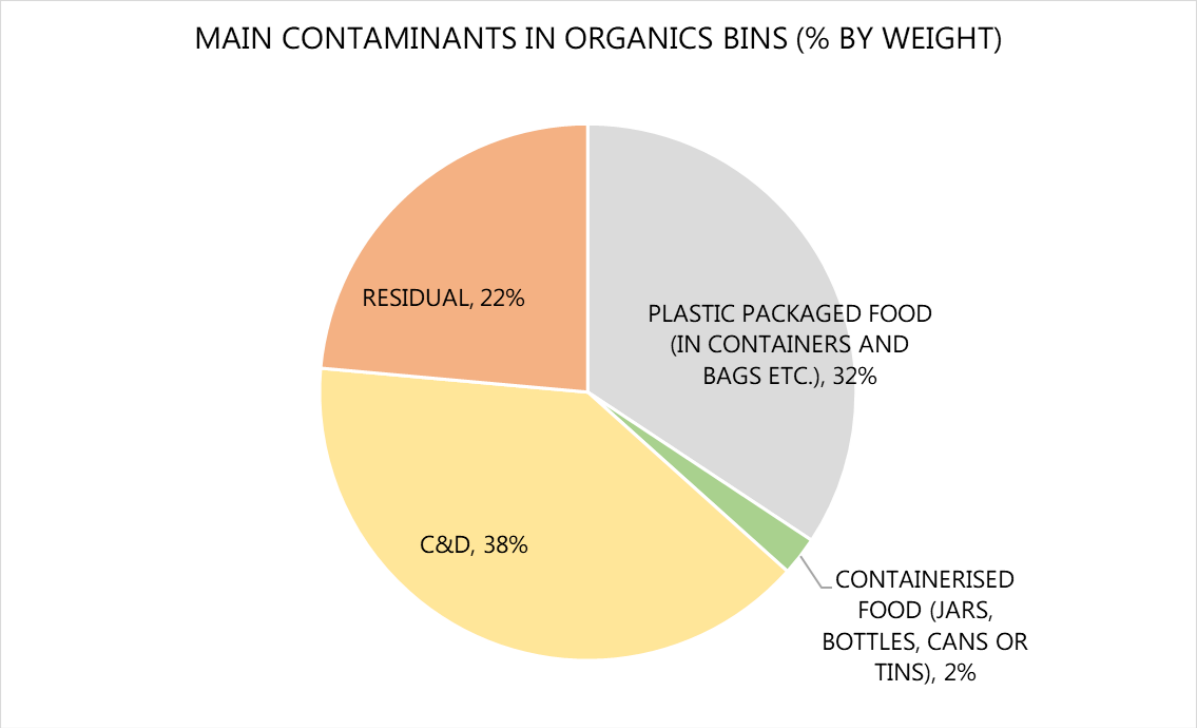


Figure 23: Main contaminants (% by weight) in the organics bins (all organics bins audited - 214)

4.3 Contamination of comingled recycling bins

Average contamination in the total comingled recycling material audited was 10.1 per cent. This varies by household from 0 to 100 per cent. Figure 24 shows how contamination rates vary by households. More than half of households (55 per cent) have very low amounts of contamination (<2 per cent by weight). A further 22 per cent of households have contamination between 3 and 10 per cent by weight. Almost a quarter of households (23 per cent) have unacceptable levels of contamination (>10 per cent contamination).

Contamination rates for comingled recycling bins are well below the average for Adelaide metropolitan councils of 13 per cent[17]. Note that:

- Due to the reduced mechanical handling experienced by the bins, the amount mixed glass/fines (10-50mm) identified during the audit will be a smaller proportion of the comingled

[17] Green Industries SA. (2019). Adelaide Metropolitan Area Kerbside Waste Performance Report 2016-17.

recycling than received at the MRF. This may be due to greater care taken during auditing and in handling of the material. The bins that were audited were manually placed on the truck by the auditors, as opposed to the automatic unloading the bin contents directly in the truck. The bin contents were also handled by hand during the audit versus by a loader at the MRF.

- Lighter contaminants such as soft plastic (plastic film, loose plastic bags) can have significant impacts on processing and sorting activities at the material recovery facility (MRF) (e.g. can get stuck in conveyor belts).

Contamination remains a significant challenge within the comingled recycling bins and residual waste. Bagged recyclables, e-waste and soft plastics are consistently in the top main contaminants, as illustrated in Figure 25.

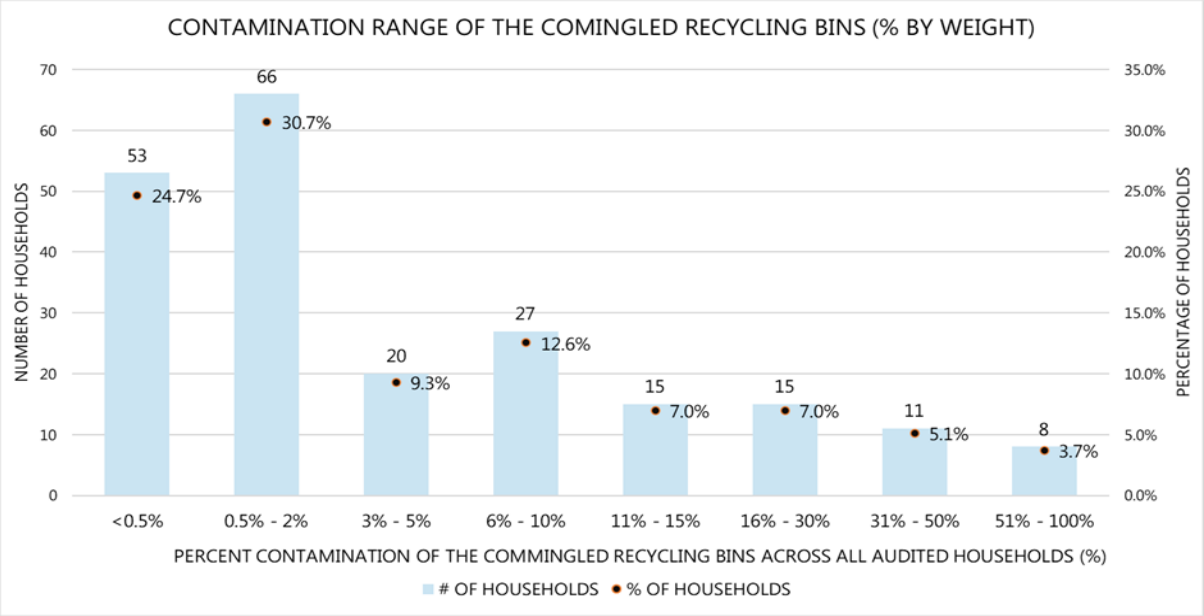


Figure 24: Distribution of the per cent contamination of the comingled recycling bin (all audited comingled recycling bins)

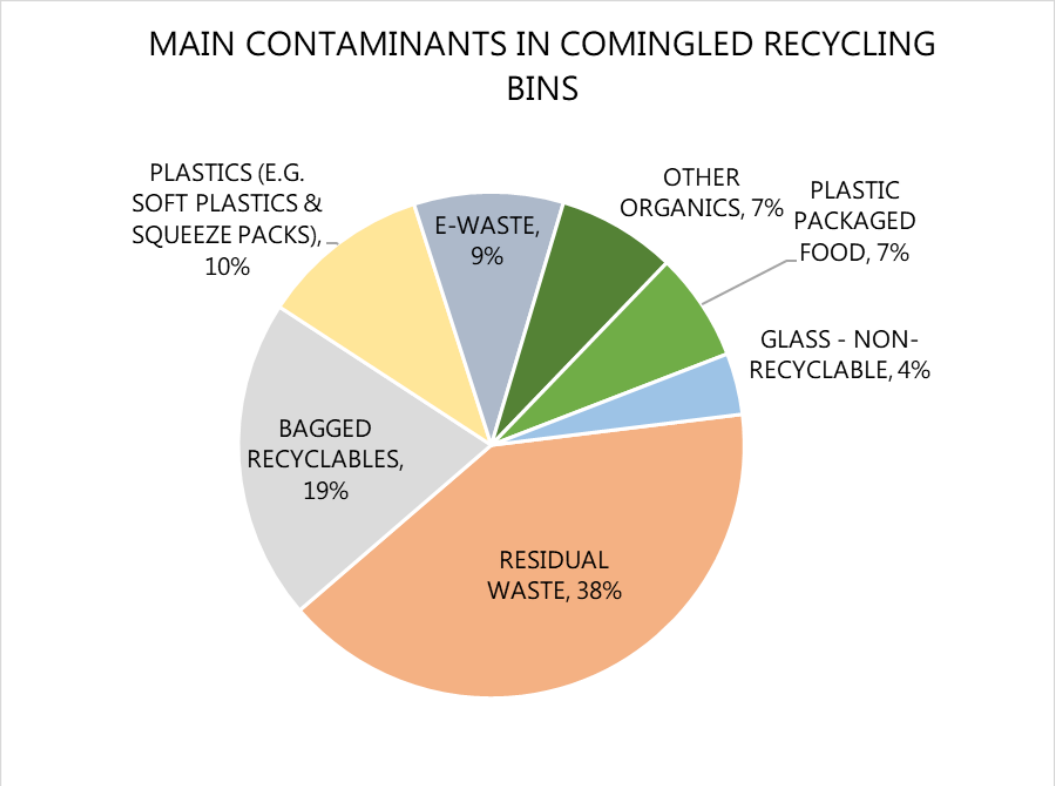


Figure 25: Main contaminants (% by weight) in the comingled recycling bins (average across all households audited)

4.4 Correlations between behaviours

Insight: People in households that place their food waste in the organics bin are more likely to recycle properly (i.e. have lower contamination in their comingled bin) (Figure 26).

The comingled recycling bins of households that separated more than 80 per cent of their food waste into the organics bin (with high food waste efficiency), on average, had 5.7 per cent contamination. The average contamination rate of all comingled recycling bins is almost double at 10.1 per cent. This is further confirmed by a *t*-test, which shows that the average percentage contamination of comingled recycling bins of households with high food waste efficiency is significantly lower than that of other households (*p*-value =0.03).

However, this is **not** always the case. 16 per cent of households with high food waste efficiency had more than 10 per cent contamination of their comingled recycling bin.

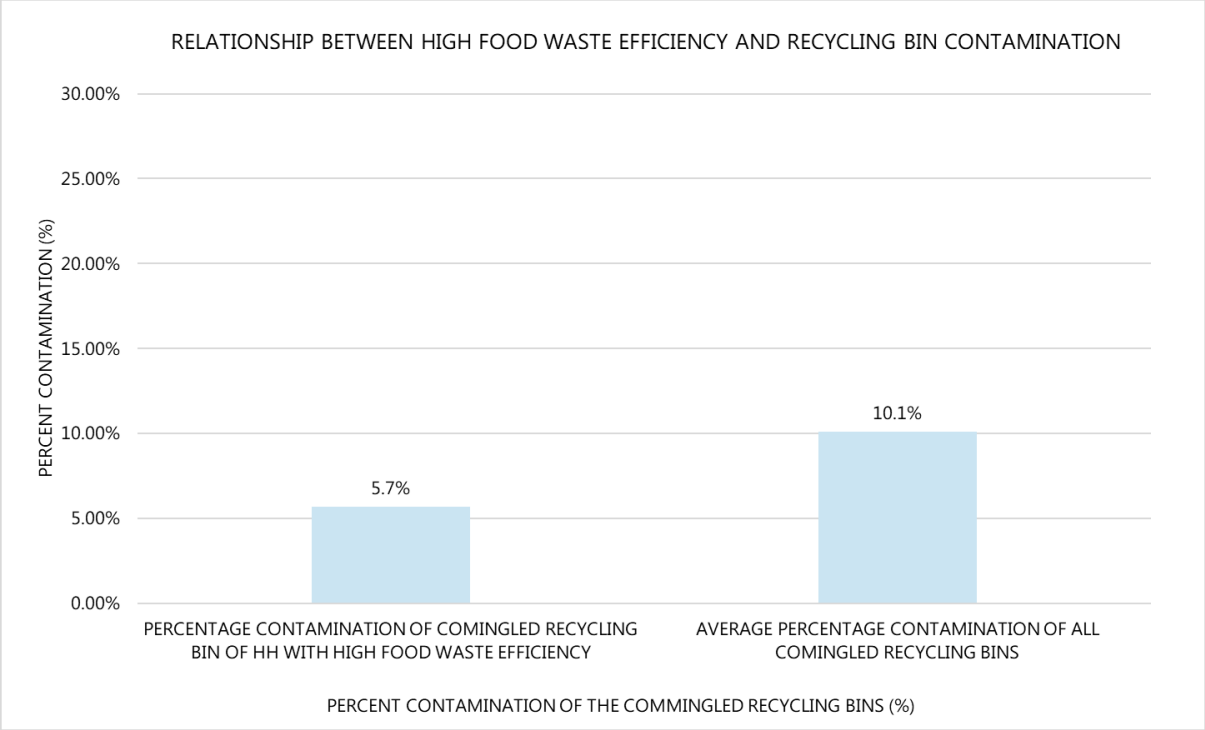


Figure 26: Relationship between high food waste efficiency and recycling bin contamination

Insight: there is no correlation between contamination in organics and comingled recycling bins

The scatter plot in Figure 27 and the correlation test show there is no significant correlation (correlation coefficient=0.06; *p*-value=0.46) to show that households that have low or no contamination in their organics bins are more likely to also have low or no contamination in their comingled recycling bins.

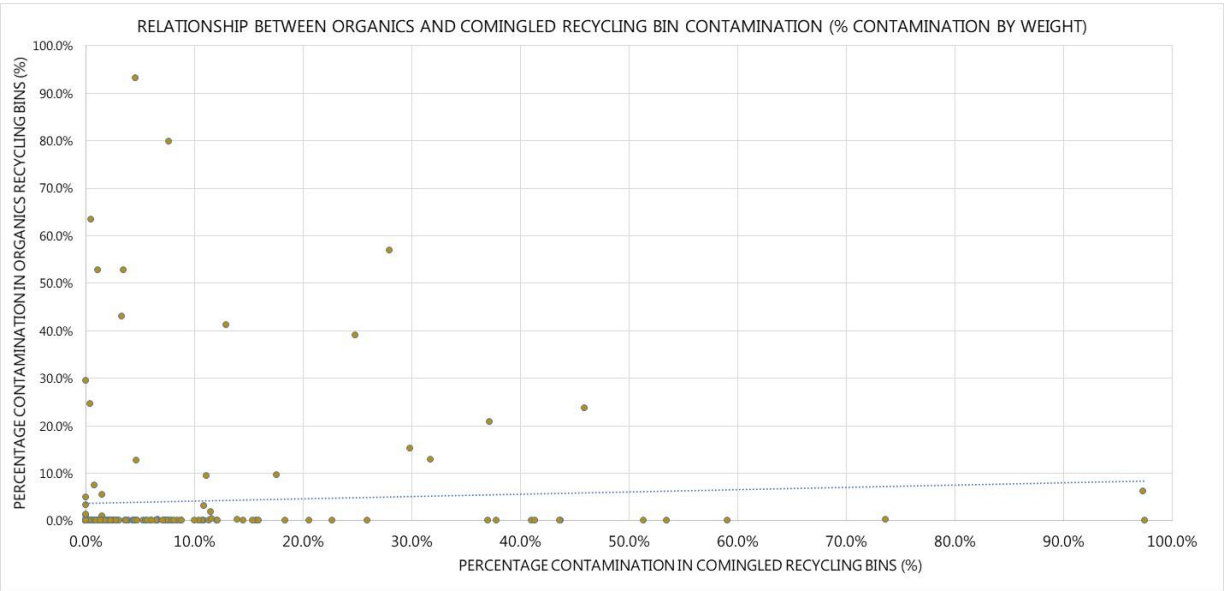


Figure 27: Relationship between organics and comingled recycling bin contamination

5. Results – other streams of interest

5. Other streams of interest

5.1 Textiles

Almost two-thirds (62 per cent) of audited households placed textiles into their kerbside bins. Most households (54 per cent) put textiles in the residual waste bins.

Figure 28 shows the distribution of textiles presented in kerbside bins. 13 per cent of audited households placed textiles in the comingled recycling bins, where they are a contaminant. Options exist for reusing textiles, such as donating good quality clothing, and reusing old textiles as rags. While it is possible to compost items made entirely from pure wool, cotton, silk, linen, hemp, and ramie (or a blend of any of those), this needs to be done in home composting systems as fabrics are not accepted in the kerbside organics bin.

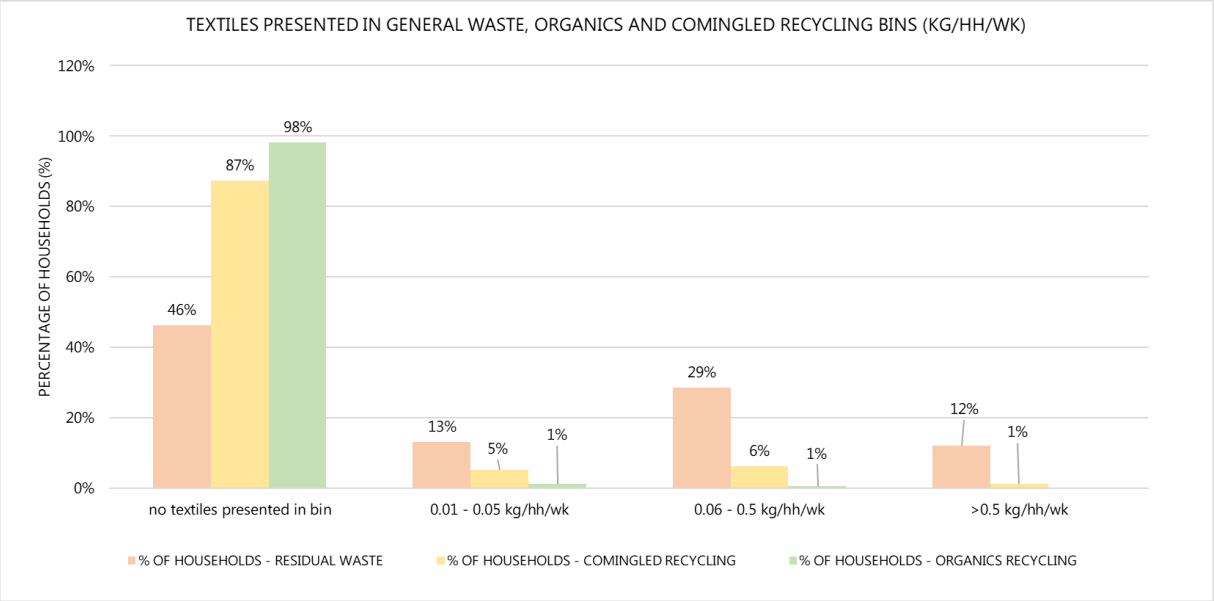


Figure 28: Textiles presented in residual waste, organics and comingled recycling bins (kg/hh/wk)

5.2 E-waste

E-waste is banned from landfill and cannot be placed in any of the 3 residential kerbside bins. However, the audit found that 23 per cent of households placed e-waste in their kerbside bins. Type of e-waste that was discarded included smaller items, such as mobile phone, chargers and larger items such as electrical goods, kitchen appliances, cables, etc. Free drop-off locations for e-waste are available across Adelaide. Some councils even provide an e-waste collection point through their depots, where residents can drop off their old phones, laptops, etc.

Figure 29 shows the distribution of e-waste presented in kerbside bins. 1 per cent of households audited placed e-waste in the organics bin, 7 per cent placed e-waste in the yellow bin, and 18 per cent placed e-waste in the residual bin.

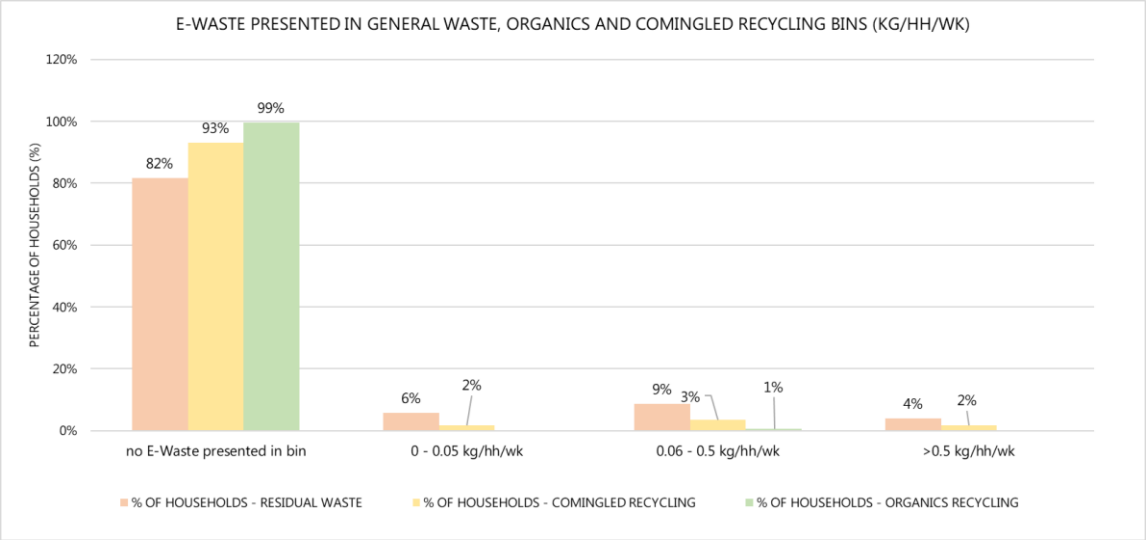


Figure 29: E-Waste presented in residual waste, organics and comingled recycling bins (kg/hh/wk)

Insight: Nearly a quarter of households placed e-waste in their kerbside bins

E-waste is banned from landfill and is a contaminant in all kerbside bins. Continued education efforts are needed to inform residents of this and encourage them to recycle their e-waste via the available drop-off services.

5.3 Soft plastics

Soft plastics cannot be recycled at kerbside. Instead, residents can drop off soft plastics for recycling at participating supermarkets through the RedCycle initiative. However, the audit found that most residents (87%) are continuing to dispose of their soft plastics via kerbside systems.

- 67 per cent of households put soft plastics in their residual waste bin.
- 54 per cent of households put soft plastics in their comingled recycling bin.
- 7 per cent of households put soft plastics in their organics bin.

6. Next steps

6. Next steps

As mentioned in the Executive summary, East Waste is collaborating with the Fight Food Waste Cooperative Research Centre (CRC), led by the University of Adelaide, with partners Green Industries SA, and Rawtec on the *WWW (What, Where and Why) of Household Food Waste Behaviour* project. This project provides deeper insights into at-home food disposal behaviours.

As part of the study, project partners commissioned South Australia's first large-scale household bin-by-bin kerbside audit. This report summarises the audit findings. These findings can be used by project partners to design more effective programs to reduce household food waste, lower bin contamination, and increase landfill diversion performance

The next step of this study is to link the demographic and other characteristics of bin audit areas (e.g. green space, Socio-Economic Indexes for Areas (SEIFA)) and demographic and socio-economic characteristics of households (e.g. age, gender, education) with individual waste disposal and recycle behaviours. To do this, a questionnaire survey was conducted in the bin audit area. Besides demographic and socio-economic characteristics of households, questions cover the following areas:

- self-reported food-related behaviours
- food waste disposal behaviours
- personal attitudes/value/belief towards food waste and environment

Questionnaire surveys were used to ask households for the amount of food they produce in a week, the different types of food waste that their households produce, and the way they discard food waste.

A comparison will be made between different measurement methods, including questionnaire survey and the bin audit. Moreover, the possible association between food waste behaviour and other factors (e.g. pro-environmental behaviours, personal attitude toward food waste and environment) will also be investigated using different methods. Finally, suggestions will be provided to help consumers change their food waste disposal behaviours based on estimation results.

Appendix 1 – Average weight and material separation efficiency by material stream

Table 8 shows the different audit categories and the percentage of households that had them in any of their kerbside bins. It also shows the average weight of these materials

- across all households
- across the households which had these materials in their bins

Table 8 also shows the material separation efficiency for streams that can be recovered. This data is for households with 3 matched bins.

Streams	*% households with waste presented*	*Average weight across all households*	*Average weight for households that presented stream*	*Average material separation efficiency*
	%	*kg/hh/wk*	*kg/hh/wk*	*%*
Organic garden waste (lawn clippings, leaves, weeds, prunings, branches etc.)	97.1%	5.6	5.80	98.5%
Organic garden waste in starch bags	0.6%	0.0	0.02	100.0%
Wood (compostable)	5.1%	0.0	0.39	55.6%
Pet waste (loose and in compostable bags)	13.7%	0.1	0.38	64.4%
Bagged garden waste (including pet waste in non-compostable bags)	1.1%	0.0	0.30	0%
Compostable serviceware	4.0%	0.0	0.04	0.0%
CDS metal cans and containers (e.g. beer can)	29.7%	0.0	0.05	67.3%
Non-CDS metal bottles and containers	1.1%	0.0	0.01	100.0%
Aluminium trays or foil rolled in ball or other	64.0%	0.0	0.06	21.5%
Non-ferrous - other	4.0%	0.0	0.12	6.4%
Aerosol (aluminium/steel)	26.3%	0.0	0.09	66.7%
Steel packaging (food and pet food tins)	82.3%	0.1	0.13	75.3%
Steel - other (fry pans, cutlery (taped bundles), clean paint tins etc.)	23.4%	0.1	0.36	36.9%
CDS glass bottles	29.1%	0.1	0.43	85.2%

Wine bottles	58.9%	0.7	1.23	96.2%
Spirit bottles	14.9%	0.1	0.41	100.0%
Other glass beverage bottles and containers	3.4%	0.0	0.20	100.0%
Glass food jars, bottles and containers	78.3%	0.3	0.37	85.3%
Glass - non-recyclable (Pyrex/ food containers, window etc.)	0.0%	0.1	0.26	
Glass acceptable broken glass >50mm	6.9%	0.0	0.20	75.0%
Mixed glass/fines (10-50mm)	0.0%	0.0	0.05	
CDS plastic bottles and containers	42.9%	0.0	0.06	85.5%
Non-CDS beverage plastic bottles and containers	80.0%	0.1	0.09	98.3%
Squeeze packs (e.g. yogurt, toothpaste, moisturiser etc)	0.0%	0.0	0.03	
Rigid plastics (food packaging, trays, plant pots etc.)	100.0%	0.5	0.51	54.9%
Other rigid plastic (lids and small hard plastics in plastic container)	2.3%	0.0	0.16	75.0%
Soft Plastic (plastic film, loose plastic bags etc.)	86.9%	0.2	0.23	
CDS LPB bottles and containers	19.4%	0.0	0.04	66.8%
Non-CDS LPB bottles and containers	57.7%	0.0	0.06	86.5%
Newspaper	43.4%	0.4	0.82	91.0%
Paper (glossy, magazines, junk mail, envelopes, etc.)	95.4%	0.7	0.73	76.9%
Paper (white/coloured computer, office etc.)	38.3%	0.1	0.18	72.1%
Cardboard (Corrugated/non-corrugated cardboard)	99.4%	0.9	0.90	83.1%
Coffee cups (disposal)	0.0%	0.0	0.04	
Coffee cups - compostable – disposable	5.1%	0.0	0.03	22.2%
Paper (shredded loose)	2.3%	0.0	0.45	75.0%

Paper (shredded in bags)	0.0%	0.0	0.0	
Soiled paper and cardboard (compostable - soiled, wet, tissues etc.)	85.7%	0.4	0.41	5.2%
Bagged recyclables	5.1%	0.1	1.47	
C&D material (building materials and fittings)	4.0%	0.2	5.54	
Dust, dirt, rock, ash	10.3%	0.4	3.73	
Batteries - alkaline	8.0%	0.0	0.11	
Batteries -hazardous	0.6%	0.0	0.04	
E-waste (small - mobile phones, chargers etc.)	15.4%	0.0	0.31	
E-waste (large - electrical goods, kitchen appliances, cables etc.)	3.4%	0.1	2.95	
E-waste (all categories)[18]	22.9%	0.2	0.69	
Light globes (including fluorescent tubes)	5.7%	0.0	0.10	
Medical waste (needle sticks, bio contaminants, pills, drugs)	15.4%	0.0	0.10	
Hazardous material (gas bottles, chemicals, engine oil, paint tins containing paint etc.)	1.1%	0.0	2.66	
Other Hazardous - specify (e.g. asbestos)	0.6%	0.0	0.19	
General waste (loose and in bags)	97.7%	1.5	1.49	
Ceramics	10.3%	0.1	0.51	
Textiles (clothing, footwear, leather, rubber etc.)	62.3%	0.3	0.53	
Sanitary (nappies and hygiene products)	28.0%	0.3	1.04	

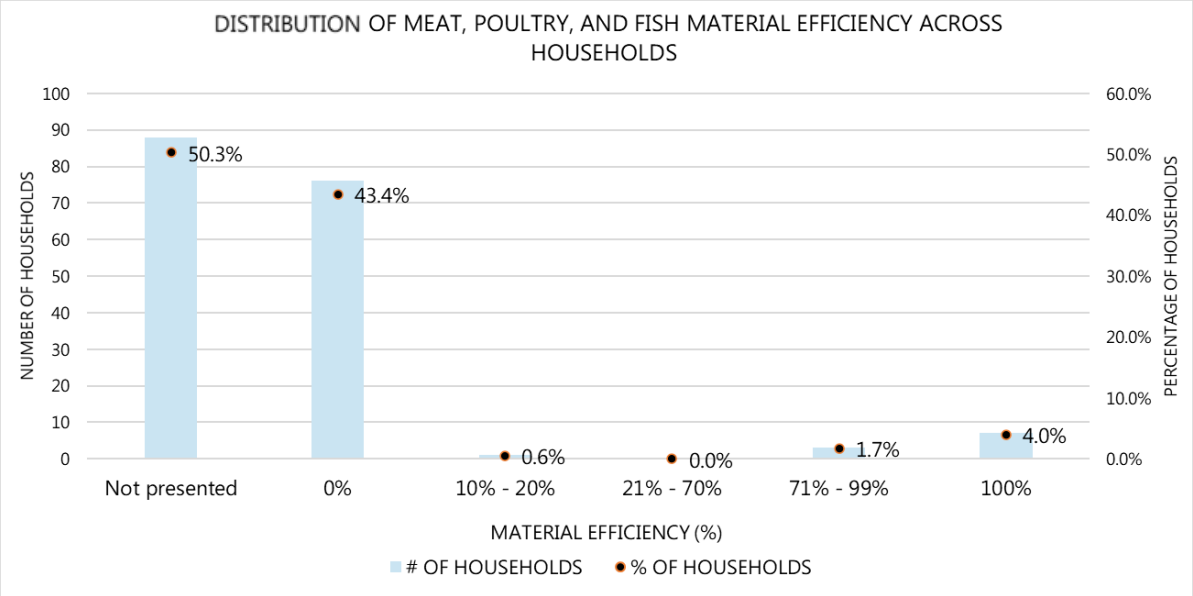
Table 8: Different waste stream, their presentation across households and the material separation efficiency (for households with 3 matched bins)

[18] Some households disposed of multiple categories of e-waste, so are counted each time in the relevant individual categories, but only once in the 'all categories'.

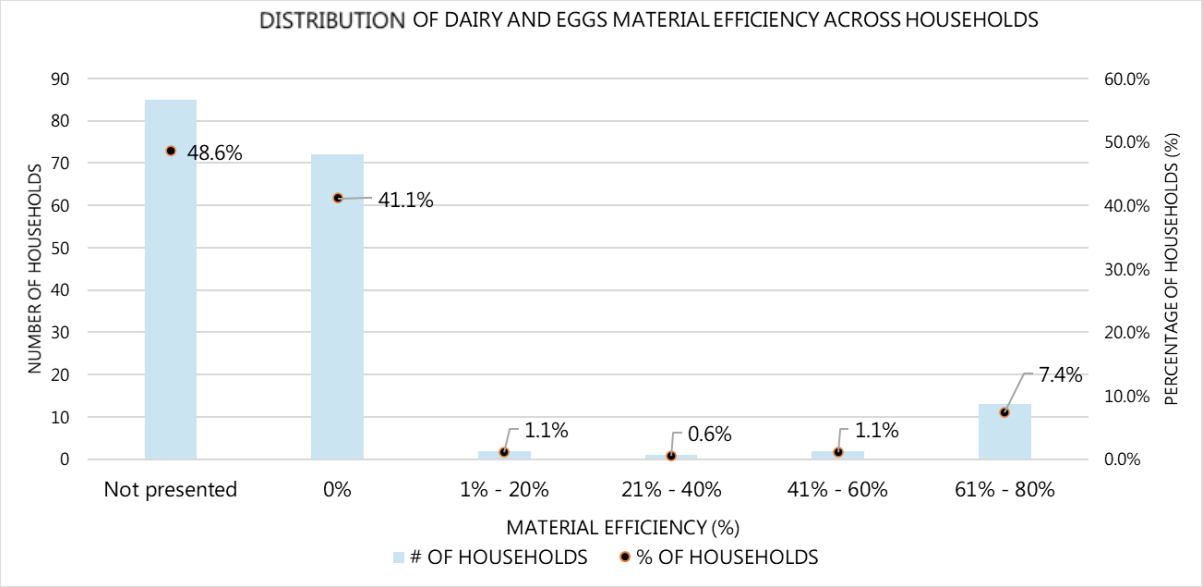
Appendix 2 – Distribution of material separation efficiencies across different material streams

The following figures show material separation efficiencies across different material streams for households with 3 matched bins[19].

Meat, poultry, and fish

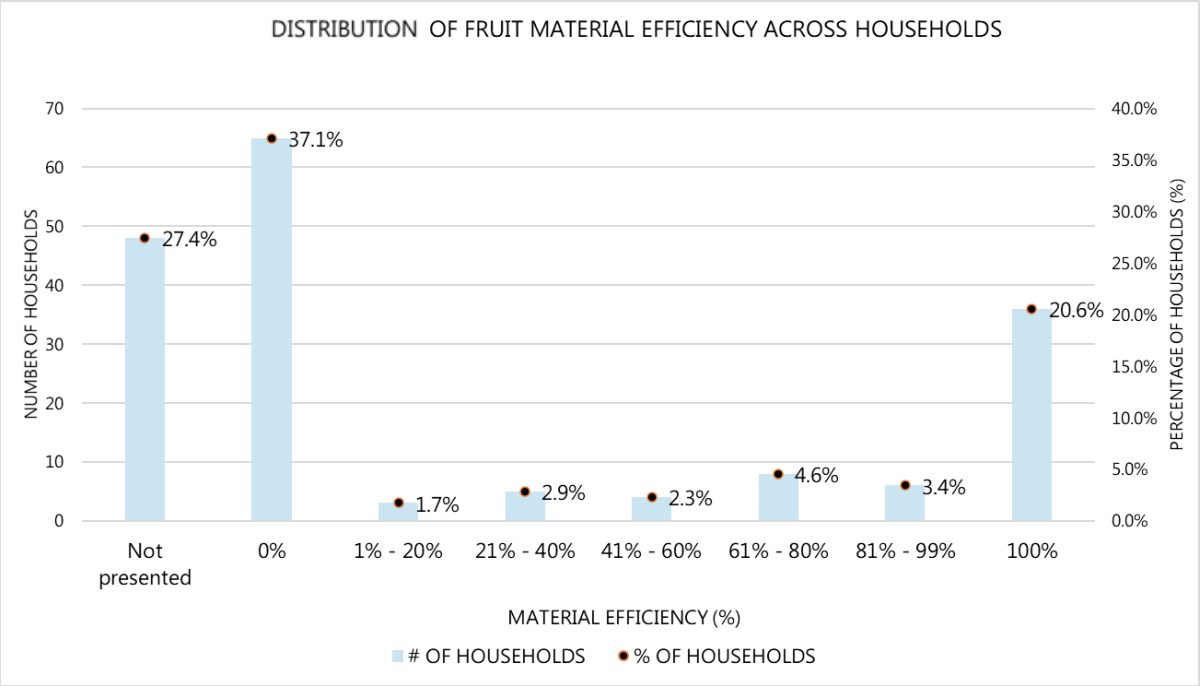


Dairy and eggs

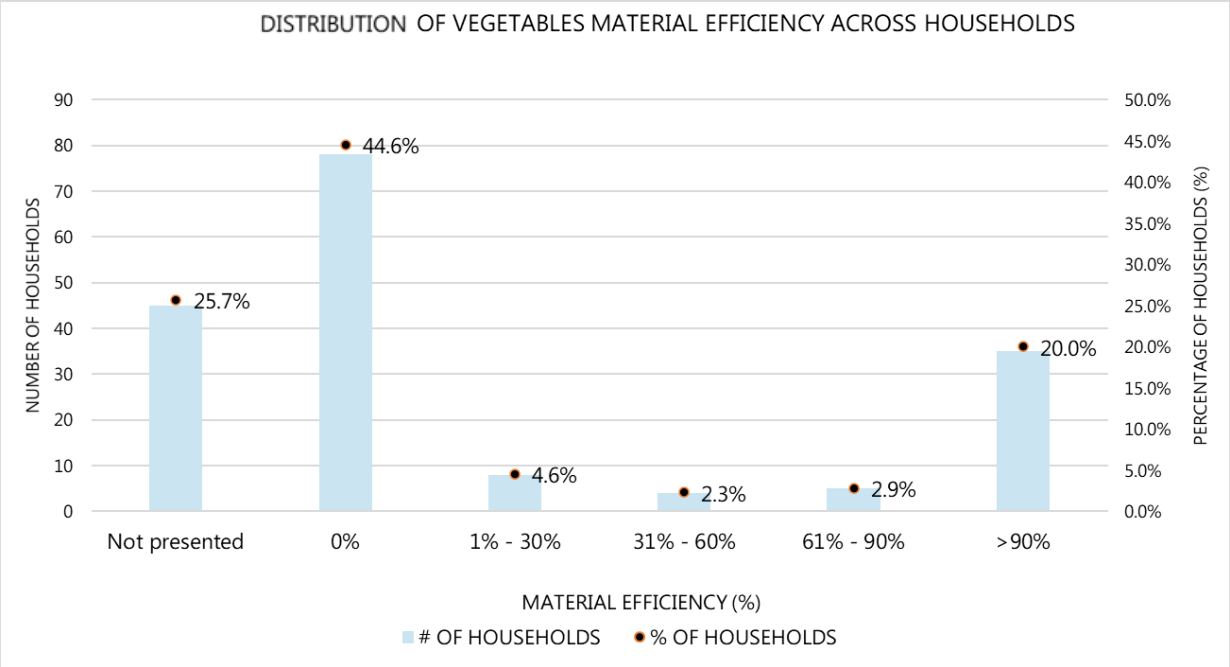


[19] Material efficiencies for food waste streams include all food waste regardless of how it is presented, including loose, in compostable bags, wrapped in newspaper, and packaged food (i.e. containerised food and food in plastic bags).

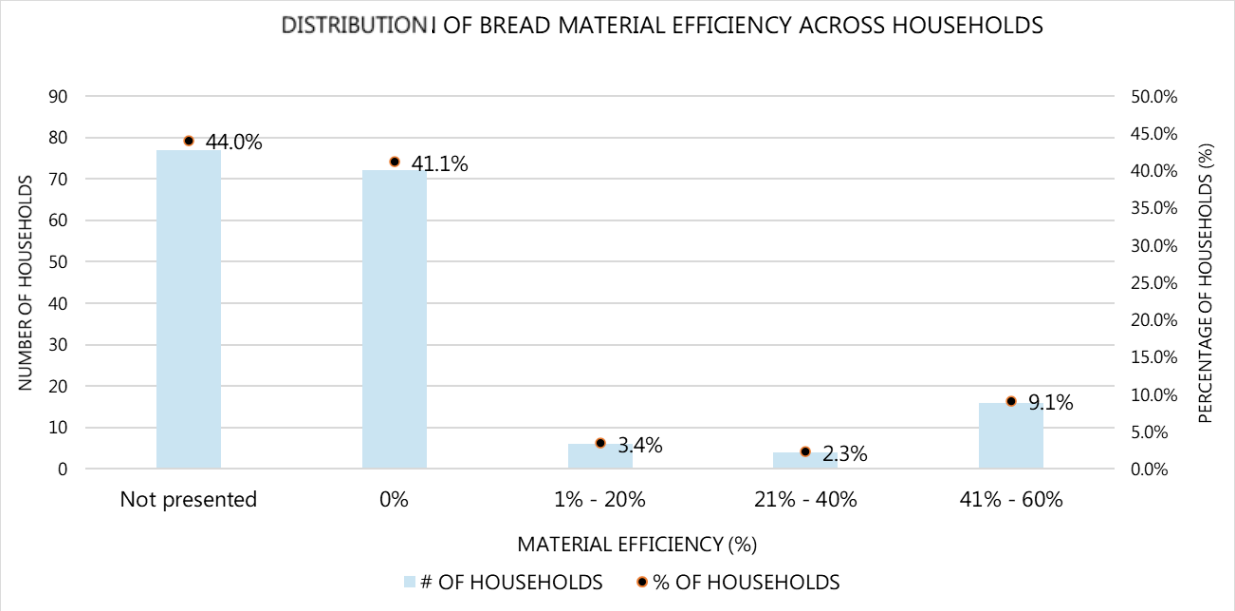
Fruit



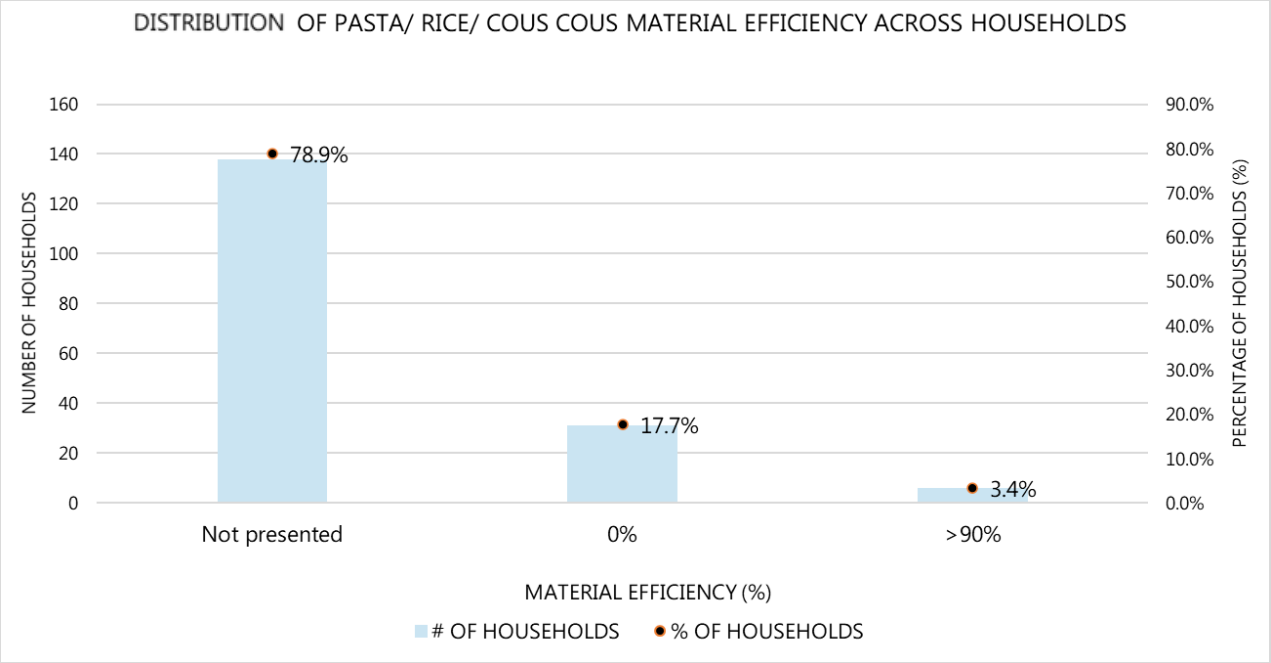
Vegetables



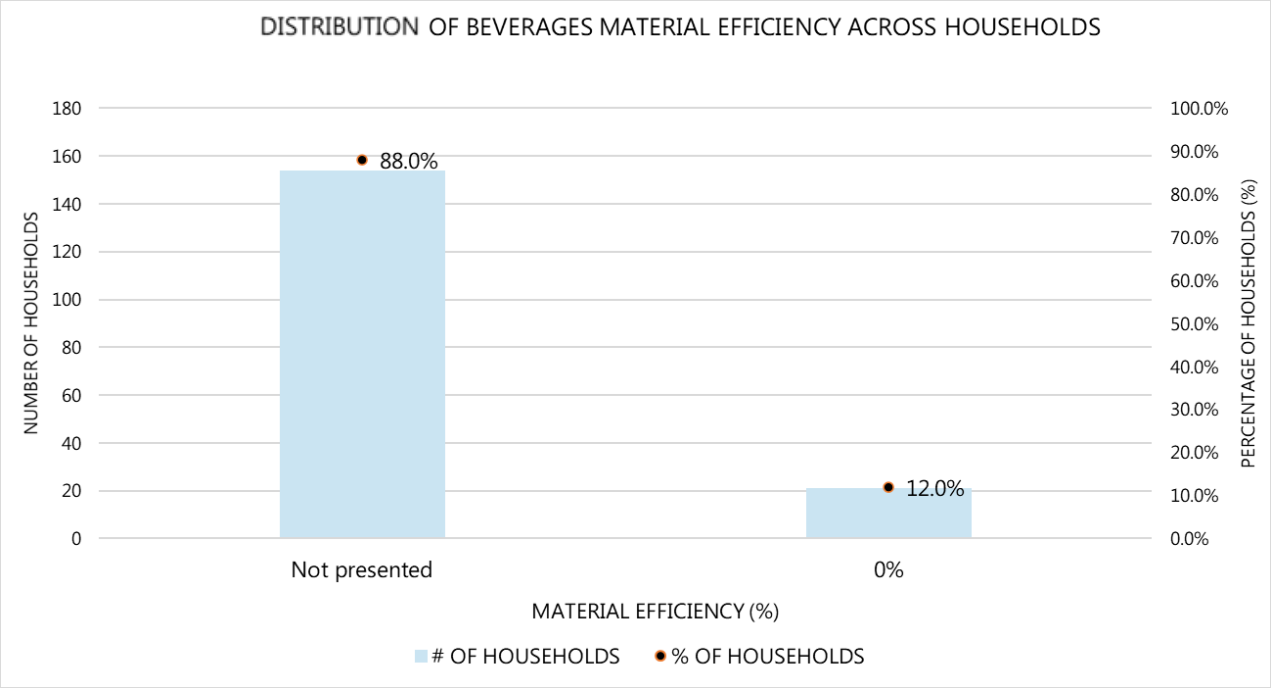
Bread



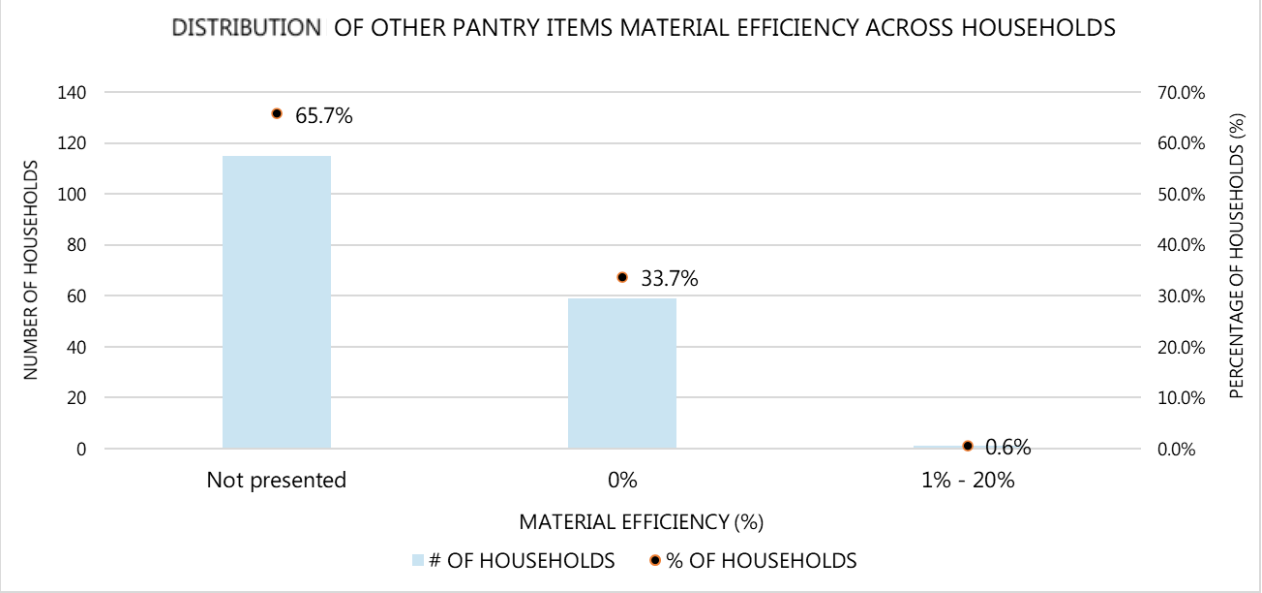
Pasta/ rice/ cous cous



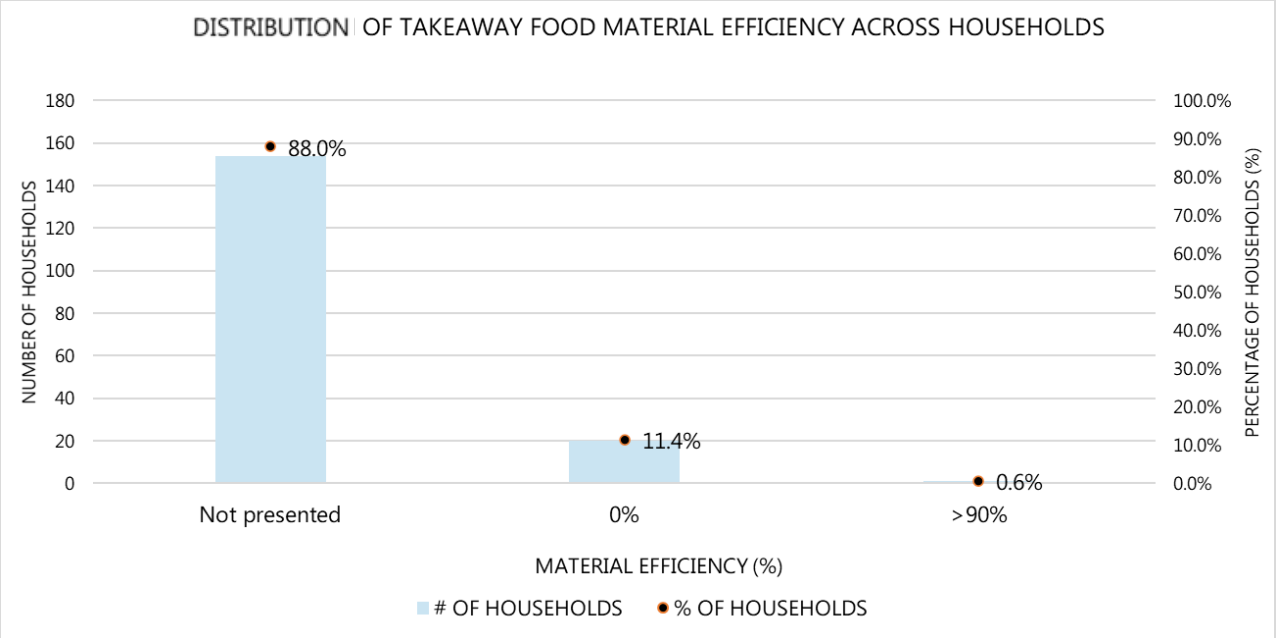
Beverages



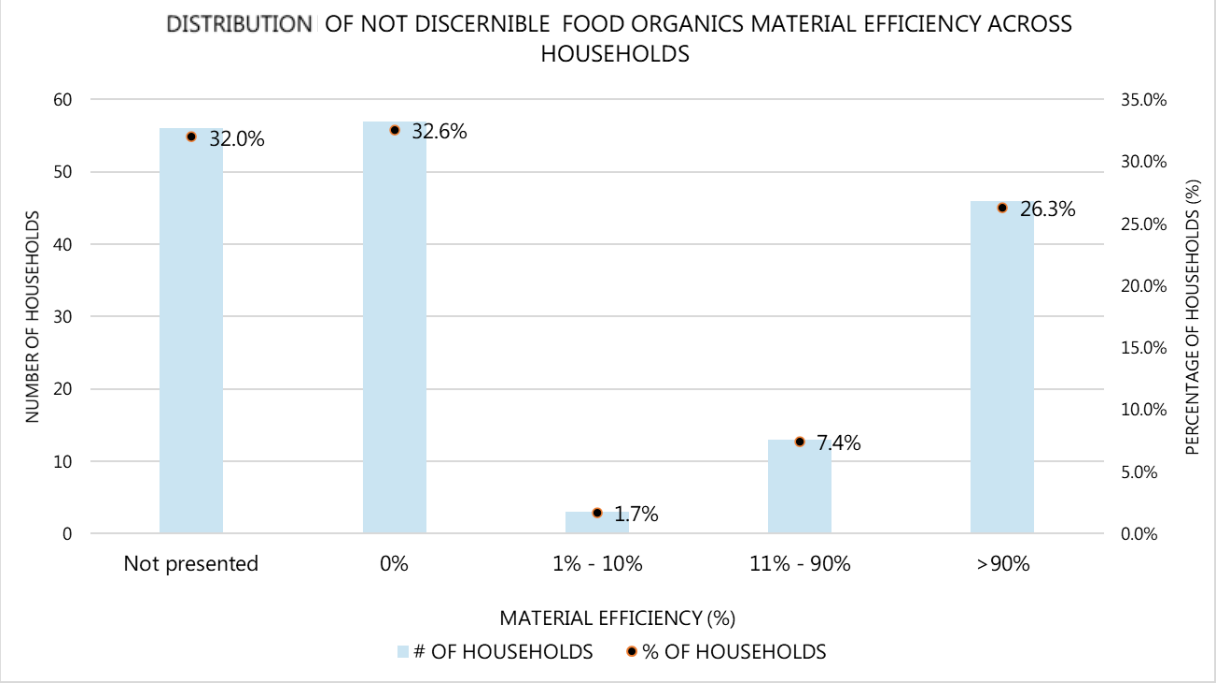
Other pantry items



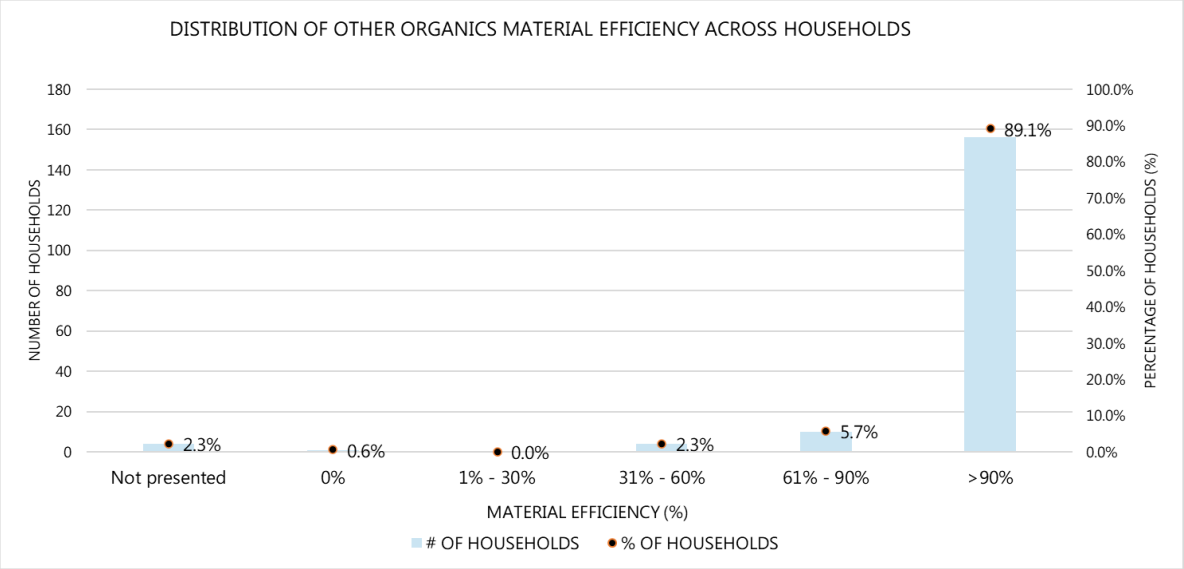
Takeaway food



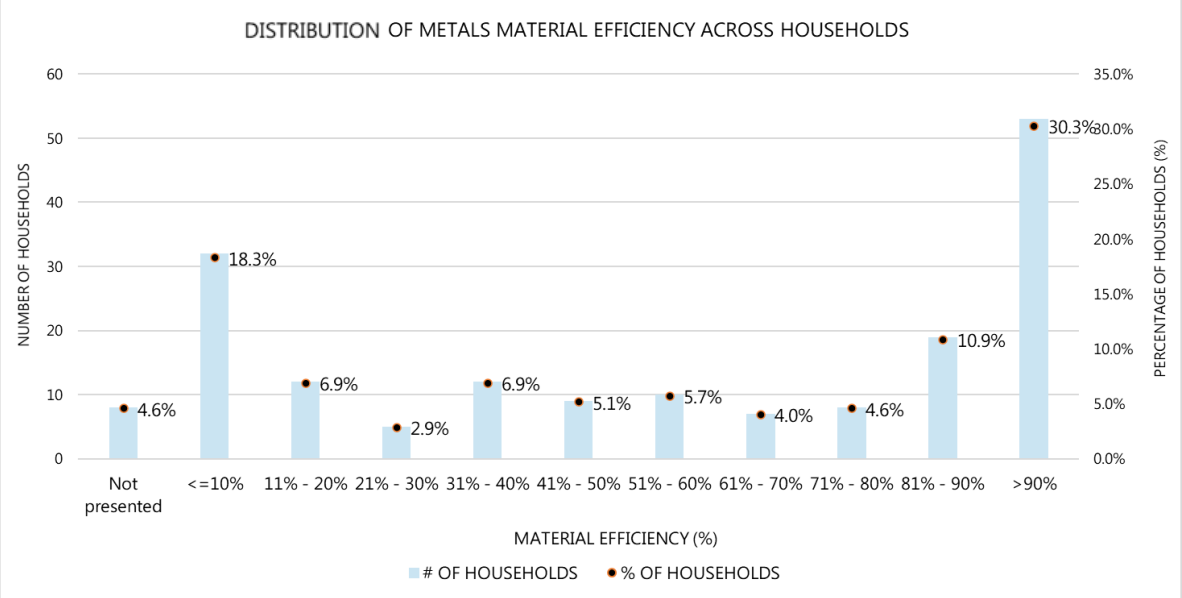
Not discernible food organics



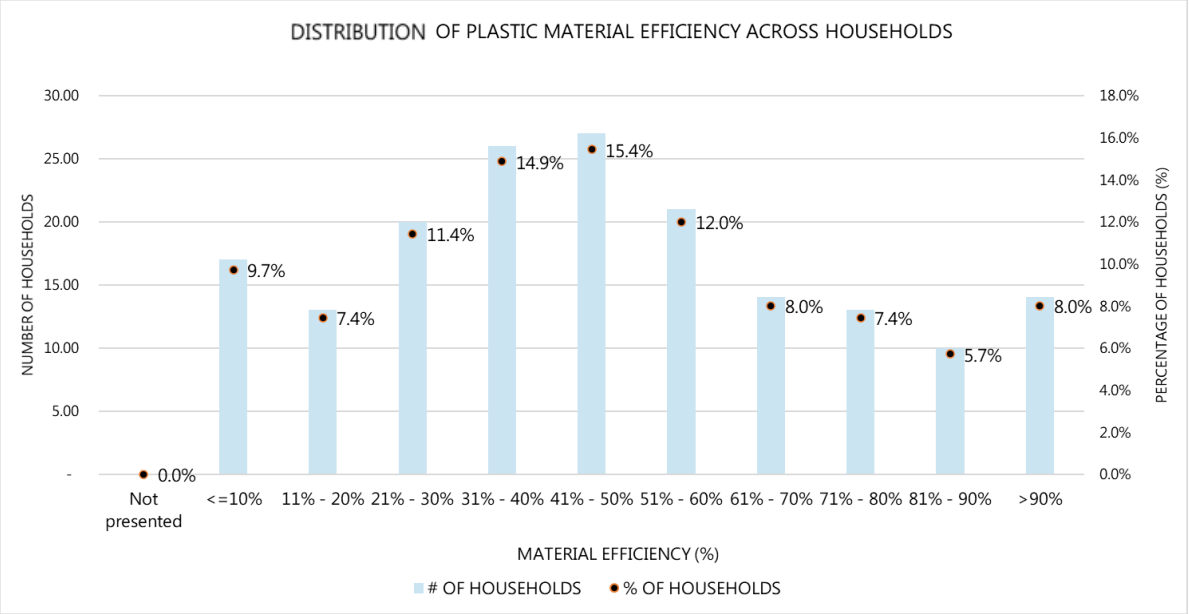
Other organics (excluding food)



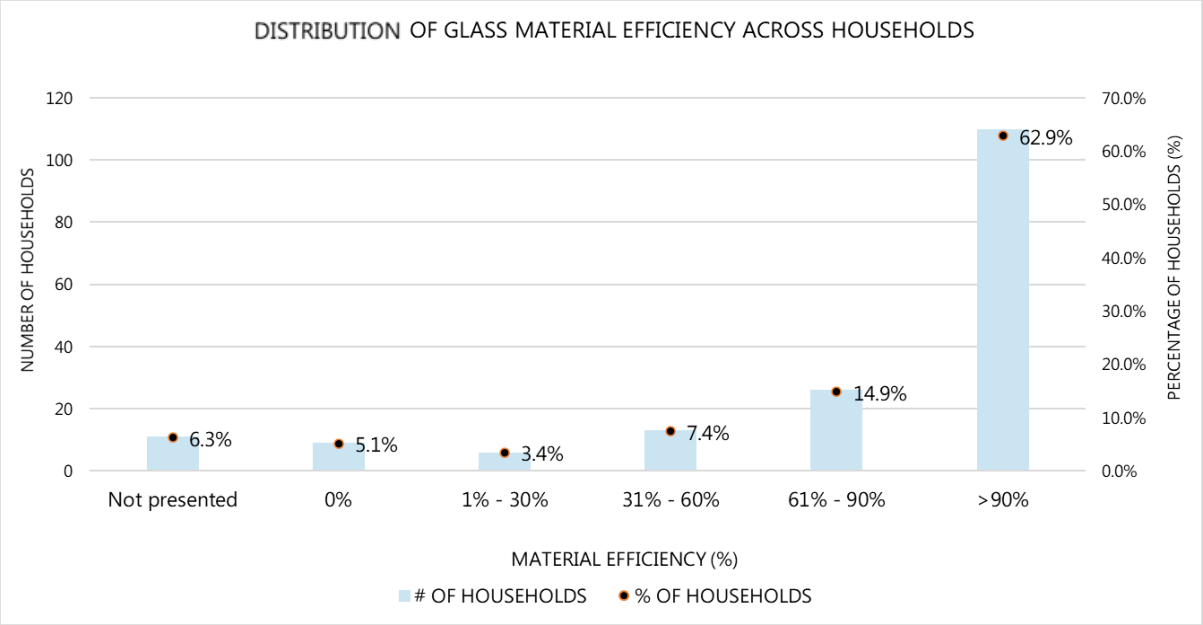
Metals



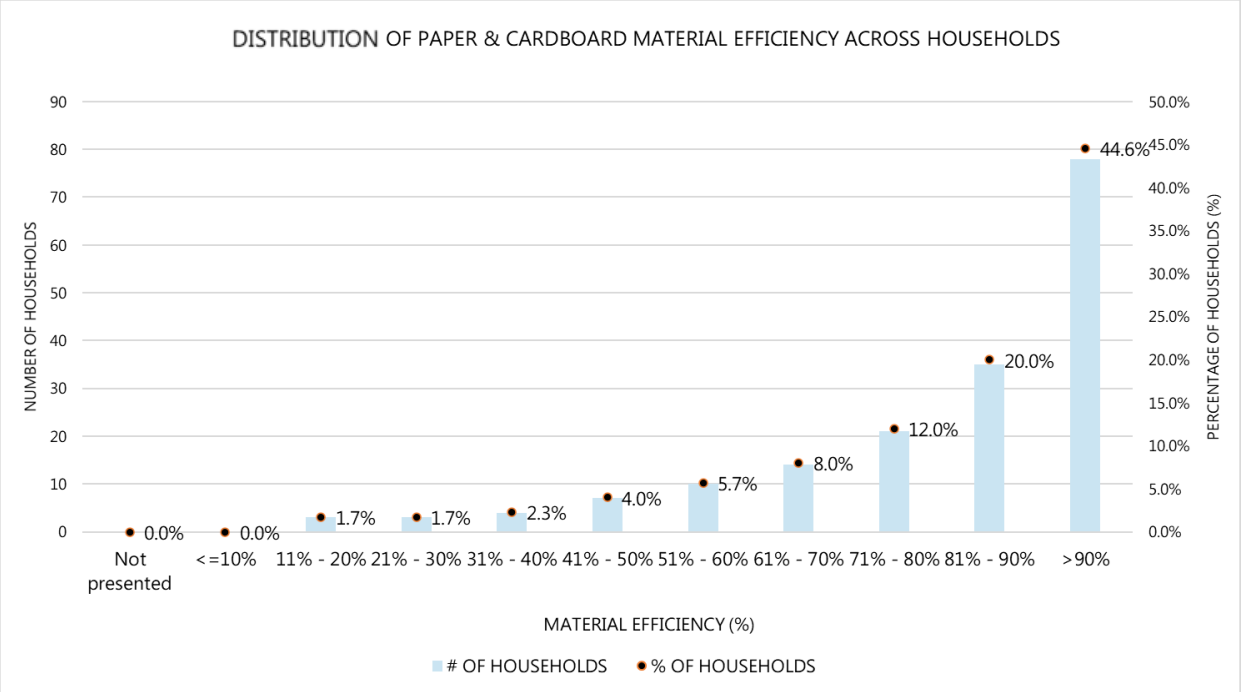
Plastic



Glass



Paper and Cardboard



Appendix 3 – Audit categories

Table 9 below outlines the audit categories used for the physical audit of materials. It also outlines what classification materials are given for each stream. Hazardous materials and e-waste are considered as contamination in the general waste bin, as they should not be placed in the bin at all. Some of these materials could be considered unrecovered materials, but for the purposes of this analysis are not included in this category.

Item	Residual waste		Comingled recycling		Organics	
	Unrecovered resources	Waste	Correct material	Contaminant	Correct material	Contaminant
CDS metal cans and containers	✓		✓			✓
Non-CDS metal bottles and containers	✓		✓			✓
Aluminium (trays or foil rolled in ball or other)	✓		✓			✓
Non-ferrous - other	✓		✓			✓
Aerosol (aluminium/steel)	✓		✓			✓
Steel packaging (food and pet food tins)	✓		✓			✓
Steel - other (fry pans, cutlery (taped bundles), clean paint tins etc.)	✓		✓			✓
Glass bottles (CDL)	✓		✓			✓
Glass wine bottles	✓		✓			✓
Spirits bottles	✓		✓			✓
Other glass beverage bottles and containers	✓		✓			✓
Glass food jars, bottles and containers	✓		✓			✓
Glass (acceptable broken glass >50mm)	✓		✓			✓
Mixed glass/fines (10-50mm) – Swept/raked into loose pile and weighed		✓		✓		✓
Glass - non-recyclable (Pyrex/food containers, window etc.)		✓		✓		✓
Plastic bottles/containers (CDL)	✓		✓			✓
Non-CDS beverage plastic bottles and containers	✓		✓			✓
Rigid plastics (empty bottles, food packaging, trays, plant pots etc.)	✓		✓			✓

Item	Residual waste		Comingled recycling		Organics	
	Unrecovered resources	Waste	Correct material	Contaminant	Correct material	Contaminant
Other rigid plastic (lids and small hard plastics in plastic container)	✓		✓			✓
Squeeze packs (E.g. Yogurt, toothpaste, moisturiser etc)		✓		✓		✓
Soft Plastic (plastic film, loose plastic bags etc.)		✓		✓		✓
CDS LPB bottles and containers	✓		✓			✓
Non-CDS LPB bottles and containers	✓		✓			✓
Newspaper	✓		✓		✓	
Paper (glossy, magazines, junk mail, envelopes, etc.)	✓		✓			✓
Paper (white/coloured computer, office etc.)	✓		✓		✓	
Cardboard (Corrugated/non-corrugated cardboard)	✓		✓		✓	
Coffee cups - compostable - disposable	✓			✓	✓	
Coffee cups and other plastic lined paper cups (disposal)		✓		✓		✓
Paper (shredded loose)	✓			✓	✓	
Paper (shredded in bags)		✓		✓		✓
Soiled paper and cardboard (compostable - soiled, wet, tissues etc.)	✓			✓	✓	
Mixed recycling in plastic bags		✓		✓		✓
Organic garden waste (lawn clippings, leaves, weeds, prunings, branches etc.)	✓			✓	✓	
Organic garden waste in starch bags	✓			✓	✓	
Food/kitchen (in compostable starch bags)	✓			✓	✓	
Food/kitchen (loose)	✓			✓	✓	
Containerised food (jars, bottles, cans or tins)		✓		✓		✓[20]
Plastic packaged food (plastic containers and bags etc.)		✓		✓		✓[20]
Wood (compostable)	✓			✓	✓	

[20] The correct destination for food waste is the organics bin, but any non-compostable packaging or containers (e.g. plastic) around the food is a contaminant.

Item	Residual waste		Comingled recycling		Organics	
	Unrecovered resources	Waste	Correct material	Contaminant	Correct material	Contaminant
Pet waste (loose and in compostable bags)	✓			✓	✓	
Bagged garden waste (including pet waste in non-compostable bags)		✓		✓		✓
Compostable service ware	✓			✓	✓	
C&D material (building materials and fittings)		✓		✓		✓
Dust, dirt, rock, ash		✓		✓		✓
Batteries - alkaline	✓			✓		✓
Batteries - hazardous	✓			✓		✓
E-waste (small - mobile phones, chargers etc.)	✓[21]			✓		✓
E-waste (large - electrical goods, kitchen appliances, cables etc.)	✓[22]			✓		✓
Light globes (including fluorescent tubes)		✓		✓		✓
Medical waste (needle sticks, bio contaminants, pills, drugs)		✓		✓		✓
Hazardous material (gas bottles, chemicals, engine oil, paint tins containing paint etc.)		✓[23]		✓		✓
Other Hazardous - specify (e.g. asbestos)		✓[24]		✓		✓
General waste (loose and in bags)		✓		✓		✓
Ceramics		✓		✓		✓
Textiles (clothing, footwear, leather, rubber etc.)		✓		✓		✓
Sanitary (nappies and hygiene products)		✓		✓		✓
Other separately reported (unclassified, miscellaneous, notable items e.g. vehicle batteries)		✓		✓		✓

Table 9: Audit categories

[21] E-waste is recyclable through drop off e-waste recycling stations/facilities around Adelaide) if separated appropriately.
[22] E-waste is recyclable through drop off e-waste recycling stations/facilities around Adelaide) if separated appropriately.
[23] Hazardous materials should not be placed in the general waste bin. Some items in this category, including paint, oil, light globes and gas bottles can be recovered if taken to an appropriate facility.
[24] Hazardous materials should not be placed in the general waste bin. Some items in this category, including paint, oil, light globes and gas bottles can be recovered if taken to an appropriate facility.

Appendix 4 – Audit photos

Figure 31: Food wrapped in compostable bags on top of a residual waste bin marked with its unique ID, bin weight and bin fullness

Figure 30: Fruit found in residential kerbside bins

Figure 33: Packaged food found in residential kerbside bins

Figure 32: Garden waste and compostable bags

Figure 35: Weighing station during the physical audit

Figure 34: Separation station during the physical audit

Appendix 5 – Letter sent to residents

Dear Resident,

We are writing to let you know about a new project involving your local Council. The project aims to reduce the amount of food waste that is sent to landfill. As you may be aware, food waste is a major challenge and it has significant environmental, economic and social consequences. It has been estimated that food waste costs Australian households on average between $2,200-$3,800 annually.[25] However, to date, most of the research on food waste has been conducted overseas, with very little in Australia (and correspondingly less research in South Australia).

The project is being led by the University of Adelaide and Eastern Waste Management Authority (East Waste). It is funded through these 2 bodies, as well as the national Australian Fight Food Waste Cooperative Research Centre (CRC). The Fight Food Waste CRC (https://fightfoodwastecrc.com.au) is funded by the Australian Government's Department of Industry, Science, Energy & Resources as part of the Australian CRC Program that supports industry-led collaborations between industry, researchers and the community.

The food waste project was launched in May 2020, and will involve micro-waste auditing, ongoing waste disposal monitoring technology including bin weighing, and household surveys and interviews to understand behaviour from a broad-section of the community.

Details of the study relevant to your Council

In particular in the next few months we will be 1) surveying 2000+ Adelaide households to understand their attitudes and concerns related to food waste; as well as conducting a variety of focus groups and personal interviews; and 2) conducting kerbside audits of 200 households' (out of 25,000+ households in the City of Burnside) green, red and yellow bins to understand how much food waste is being discarded in each bin.

How Can I Participate in the Surveys about Household Food Waste?

Households will be selected randomly both via online sampling, and via mail questionnaires. You may be given the opportunity to participate. The survey is designed to take approximately 20 minutes to complete and is completely voluntary. All of your answers to the questions are strictly anonymous.

If you are interested in being on our mailing list to potentially participate in any focus groups or interviews, please email foodwaste@adelaide.edu.au.

Or register your interest through this link:

http://bit.ly/AdelaideFoodWasteStudy

Or scan this QR code:

SCAN ME

Any individual responses will remain confidential and no personally identified responses will be released at all from this study.

[25] Commonwealth of Australia 2017, National Food Waste Strategy: Halving Australia's food waste by 2030.

How Can I Participate in the Bin Audits?

In the coming few months, 200 households in the City of Burnside (which has 25,000+ households in total) will be randomly selected for audit. Auditing will be conducted on days when bins are put out for kerbside collection. Households' who are randomly selected for auditing will have their bins collected during normal kerbside rubbish collection. Bins will be replaced with a complimentary brand new rubbish bin.

Can I make sure my bins are not audited?

If for any reason you want to make sure your bins are not taken from your kerbside for auditing, then you can choose to "opt out" of the study. To "opt out" please email foodwaste@adelaide.edu.au, and record your name and address and it will be removed from our sampling database.

Participation in any part of this project is completely voluntary. You can still choose to withdraw your participation and "opt out" at any time with no coercion or any repercussions.

What will happen to my information?

With respect to both the surveys and the bin audits, all information collected will be kept completely confidential and is used for research purposes only. No release of any individual bin audits will occur. Only the project researchers will have access to participant information during the collection, recruitment phase and data analysis phase. Only (de-identified) aggregate or averaged results will be released publicly. The project outcomes will be reported in and thus accessible through CRC Fight Food Waste websites, a PhD thesis, journal articles and local newspapers and Council information wherever possible.

All records and materials will be held by the researchers at the University of Adelaide in a password protected computer and secure server for at least 5 years, consistent with the Australian Code for Responsible Conduct of Research.

Data from this project may be used by the researchers for further research related to this topic (unless you indicate that you do not wish to be part of further studies).

Your information will only be used as described in this participant information sheet and it will only be disclosed according to the consent provided, except as required by law.

Who do I contact if I have questions about the project?

Email foodwaste@adelaide.edu.au or directly contact University of Adelaide researchers

Dr Ying Xu

Phone: (08) 8313 0882

Email: ying.xu03@adelaide.edu.au

Professor Sarah Wheeler

Phone: (08) 83139130

Email: sarah.wheeler@adelaide.edu.au

Professor Wendy Umberger

Phone: (08) 8313 7263

What if I have a complaint?

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2020-242). This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research 2007 (Updated 2018). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult any of the Principal Investigators.

If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat on:

Phone: (08) 8313 6028

Email: hrec@adelaide.edu.au

Post: Level 4, Rundle Mall Plaza, 50 Rundle Mall, ADELAIDE SA 5000