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CDS Baseline Audit Report

Public Report

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Signature		

Executive Summary

Department of Water and Environmental Regulation (DWER) has commissioned Talis to undertake baseline audits of Container Deposit Scheme (CDS) eligible containers received at Materials Recovery Facilities (MRF) and through kerbside recycling collections from 11 Local Government Areas (LGAs) across WA.

The key purpose of baseline sampling data is to:

- Obtain data to compare before and after findings to determine CDS effectiveness; and
- Consider whether there are significant differences between MRFs in the number of eligible containers within output commodity types.

The number of eligible containers per kilogram (EC/Kg) of the material type sampled can be determined at the source (residential kerbside recycling bin) and/or post sorting and processing, prior to output commodities being baled at MRFs in preparation for reprocessing markets.

The results from the MRF and the LGA audits (glass fraction only) have been combined to provide a metropolitan EC/Kg value, a regional EC/Kg value and a statewide EC/Kg value. The data confidence around each figure is also provided in the form of a 95% confidence interval.

The narrower the confidence interval, the more accurate the survey estimate, the majority of the results fall within a fairly narrow confidence interval, therefore the baseline audit results are considered to be robust, recognising that a small change to any EC/Kg value has a significant multiplier effect on the number of containers.

The regional EC/Kg values are higher than the metropolitan EC/Kg values due to the hand sorting of material and therefore lower contamination rates. The State average is more heavily influenced by the metropolitan results as it is calculated as a weighted State average, refer below table.

Average number of eligible containers per kg recycling

Estimate	PET	HDPE	Mixed Plastics	Aluminium	Glass
Metro	18.88	0.37	4.11	62.61	2.34
Regional	22.6	1.04	5.31	68.24	2.78
State	19.13	0.42	4.12	63.12	2.35
C.I. metro	(18.25,19.51)	(0.32,0.43)	(3.5,4.71)	(61.11,64.1)	(2.10,2.59)
C.I. regional	(22.07,23.13)	(0.96,1.12)	(4.13,6.49)	(66.86,69.62)	(2.43,3.14)
C.I. state	(18.54,19.72)	(0.37,0.47)	(3.52,4.71)	(61.76,64.48)	(2.11,2.59)

The following table shows the number of containers calculated by applying the number of eligible containers per kilogram at the regional/metropolitan level, multiplied by the total MRF tonnage throughput for 2018/19.

Total number of eligible containers based on the regional and metropolitan EC/Kg estimates

Material	Metro EC/Kg	Regional EC/Kg	Tonnes	Total number of containers	Total value (10c/container)
PET	18.88	22.6	4,142	79,244,336	$7,924,434
HDPE	0.37	1.04	3,904	1,626,180	$162,618
Mixed Plastics	4.11	5.31	4,928	20,315,773	$2,031,577
Aluminium	62.61	68.24	2,008	126,756,805	$12,675,680
Glass	2.34	2.78	79,731	187,517,677	$18,751,768
Total			94,713	415,460,771	$41,546,077

Western Australia Return Recycle Renew (WARRRL), the scheme coordinator of the WA CDS, have indicated that approximately 1.3 billion eligible containers were sold in the State in 2018/19. Using the results from the baseline audit 415.5 million containers are recovered through MRFs giving a recovery rate of 32% of all containers sold in the State.

With the inclusion of metal recyclers and glass recyclers, an additional 1.6% is recovered. Bringing the total recovery rate to 33.6%. The metal and glass recycler tonnages are estimations and at the low range of what is likely to be actually captured in the State.

The remaining CDS eligible materials that are not currently being captured would include material in incorrect bins at households, however the capture rates of CDS eligible materials generated in households are relatively high. Seventeen per cent (17.3%) of the recyclables received at the metropolitan MRFs in 2017/18 were from commercial and industrial sources – including offices, schools, mine sites, event and hospitality venues. However there is significant potential to recover more recyclables from these sources:

- Mine sites;
- Hospitality sector (hotels, restaurants, bars and cafes);
- Institutions (hospitals, airports, schools and other government buildings);
- Other commercial & industrial sources (eg offices, retail & trade); and
- Events, public place bins and litter.

The baseline audit results provide a robust indication of the number of CDS eligible containers which were being recycled in the State through MRFs in 2018/19. However since that time there was a devastating fire at Cleanaway's South Guildford MRF which was taking 55% of WA's recyclables. It is unlikely that the MRF will be rebuilt by the time the CDS commences. Therefore the assumed eligible containers per kg for the State will change, as would the number of eligible containers being recycled in 2019/20. The fluctuations in the recycling market impact the initial recommendations about ongoing auditing until the recycling market in WA stabilises.

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1 Background

The Container Deposit Scheme (CDS) will commence in WA on Tuesday, 2 June 2020. The CDS is intended to complement existing kerbside recycling services and reduce litter through improved recovery of beverage containers consumed away from homes.

To provide baseline data on recycling rates of beverage containers within existing collection and recycling activities, the Department of Water and Environmental Regulation (DWER) commissioned Talis to undertake baseline audits of CDS eligible containers received at Materials Recovery Facilities (MRF) and through kerbside recycling collections from 10 Local Government Areas (LGAs) across WA. In addition, the City of Swan opted in to the audit program, paying for their own audit, making a total of 11 LGAs considered in this report.

The key purpose of baseline sampling data is to:

- Obtain data to compare before and after findings to determine CDS effectiveness; and
- Consider whether there are significant differences between MRFs in the number of eligible containers within output commodity types.

The number of eligible containers per kilogram (EC/Kg) of the material type sampled can be determined at the source (residential kerbside recycling bin) and/or post sorting and processing, prior to output commodities being baled at MRFs in preparation for reprocessing markets.

Container material types that have been considered include:

- Aluminium;
- Polyethylene terephthalate (PET);
- High-density polyethylene (HDPE);
- Mixed plastics; and
- Glass.

For aluminium, PET, HDPE and mixed plastics sampling has primarily been undertaken at MRFs prior to output commodities being baled for recycling. For glass, which breaks during transport and sorting, primary sampling has been undertaken from residential kerbside recycling bins.

As liquid paperboard, aseptic containers and sachets are not currently recovered for recycling from the MRFs they have not been included in the total number of containers recovered. But they have been counted and discussed in this report as a potentially recoverable material.

2 Survey design

2.1 MRF Sampling

Table 2-1 outlines the MRFs that are included in the audit. These are all the MRFs identified in WA that sort and bale materials onsite ready for markets.

At the time of the audit (October and November, 2019) the MRFs in Albany and Broome extract the glass and send the remaining baled materials to Cleanaway South Guildford. Great Southern Waste and Warren Blackwood MRFs extract the glass and send their bales to Remondis in Perth for marketing the baled product.

Warren Blackwood MRF opted-out of the audit program, therefore their results have been assumed based on an average of the other regional MRF's outputs.

Table 2-1 MRF Throughputs

MRF	End Point
Cleanaway South Guildford	Direct to markets
Suez Bibra Lake	Direct to market
Southern Metropolitan Regional Council (SMRC) Canning Vale	Direct to market
Cleanaway Albany	South Guildford MRF
Cleanaway Broome	South Guildford MRF
Esperance Shire MRF	Direct to markets
Great Southern Waste Narrogin MRF	Remondis
Warren Blackwood Kojonup	Remondis

Over a year the quantity and composition of materials received by the MRF varies based on:

- Which LGAs and commercial waste clients deliver materials;
- Seasonal factors that will influence beverage consumption (which in turn will alter the composition of recyclable material);
- Major holidays; and
- Weather conditions.

Additionally the quality of the materials produced for market throughout the year will vary within a MRF based on demand for commodity types and/or quality standards which are affected by:

- Conveyor belt speeds; and
- The effort put into manual sorting and refining of the output products.

2.1.1 Proposed methodology

The methodology was based on the *NSW EPA Materials Recovery Facility Processing Refund Protocol Sampling Strategy*. This was assessed by Pink Lake Analytics and determined to be a valid sampling methodology to base the initial WA audits on.

As per the *Sampling Strategy* the method for baseline audits include:

- The number of eligible containers per unit of weight sampled be directly counted and weighed, and then converted to a per kilogram factor and the volume recorded;
- Conduct MRF sampling as close to the end of the processing line (the baler) as possible to ensure the sample is representative of the final output;
- A sample unit of one cubic metre ($1m^3$) is, from a physical perspective, efficient; and
- 10 to 20 samples can be taken, weighed and sorted in a day.

Samples collected during the baseline audit were taken after processing but prior to baling at each of the MRFs. The data from the audits was used to determine the EC/Kg value for aluminium, PET, HDPE and mixed plastics (excluding segregated PET and HPDE).

Sampling trials commissioned by the NSW EPA showed that the number of eligible glass containers cannot be effectively sampled at MRFs due to breakage. During trials carried out in NSW, approximately 80 percent of glass could not be identified. Estimates of the number of eligible glass containers was instead determined by undertaking kerbside audits and then determining the level of contamination in processed glass at MRFs.

Liquid paperboard and aseptic containers generally remain in the paper recycling stream at a MRF, where it is a contaminant, and is therefore not reused or recycled.

2.1.2 Allocation of Days to MRFs

For a given sample size, the optimal allocation of sampling days between MRFs depends on the variability of the measure of interest (number of eligible containers per tonne) in each MRF and the weight that is given to each MRF to reflect its importance to the overall estimate.

The weight assigned to each MRF was proportional to its throughput which DWER provided approximations for prior to the audit. The relative variation in the measure of interest was unknown prior to the audit and therefore assumed to be constant across MRFs.

Table 2-2 shows the optimal allocation of sampling days.

Table 2-2: Optimal sampling days

MRF	Audit days
Cleanaway South Guildford	5
Suez Bibra Lake	3
SMRC	2
Cleanaway Albany	1
Cleanaway Broome	1
Esperance Shire MRF	1
Great Southern Waste Narrogin	1
Warren Blackwood Kojonup	1

For the two largest MRFs, Cleanaway and Suez, the audit days were split over two weeks. Warren Blackwood withdrew from the audit process, however they were part of the audit planning and their tonnage was taken into account for the audit planning.

2.1.3 MRF Sample size and frequency

The sample unit size from processed samples taken at MRFs was $1m^3$ for PET, HDPE and mixed plastics. Samples were collected in durable $1m^3$ flexible reusable bulka bags with handles.

The sample size for aluminium was $0.5m^3$ (down from $1m^3$) per sample.

Table 2-3 outlines the sample size and frequency. Due to the operational and Occupational Health and Safety (OH&S) impacts of extracting the samples just prior to baling, three samples of each commodity were generally taken at the commencement of each auditing day, or just prior to the typical baling cycle for the commodity type.

Table 2-3: Sample size and frequency

Material	Sample Size	No of Samples/day	Frequency
Aluminium	$0.5m^3$	3	All 3 samples for each material type to be taken consecutively as the material silo is opened as part of the MRF's operational cycle.
PET	$1m^3$	3	
HDPE	$1m^3$	3	
Mixed Plastics	$1m^3$	3	
Glass	10L bucket (240L bin at regional MRFs)	3	

3 Methodology

3.1 MRF audit methodology

An audit plan was established for each MRF including a clearly defined methodology, including roles and responsibilities between the MRF staff and audit team.

3.1.1 MRF Sample selection

At the metropolitan MRFs the samples were extracted from the baler area for each material.

The PET, HDPE and mixed plastics samples were collected in 1m^3 bulka bags. The aluminium was collected in 0.5m^3 bulka bags. The bulka bags were filled to level (prior to transporting) to ensure that each sample is the same size for each material.

The total number of samples collected is outlined in Table 3-1. This shows that the majority of targeted samples were collected as planned. However, some samples were missed due to a variety of operational issues at the MRFs. The main shortfall was in mixed plastics. Despite the reduced number of samples for mixed plastics the results for each MRF were fairly consistent therefore it was not considered to significantly affect the integrity of the data.

Table 3-1 – Total number of samples collected by day

MRF	PET	HDPE	Mixed Plastics	Aluminium	Glass
Cleanaway Total	16	16	5	16	14
Suez total	9	6	6	6	9
SMRC total	4	4	4	6	3 (OS) 3 (US)
Albany	3	3	3	3	3
Broome	3	3	N/A	3	3
Esperance	3	3	N/A	3	3
Narrogin	3	3	N/A	3	3
Total	**41**	**38**	**18**	**40**	**41**
Targeted loads	42	42	30	42	42

**(OS)refers to oversized glass fraction and (US) refers to undersized glass fraction*

3.1.2 MRF Sorting method

Each sample was hand sorted based on CDS eligible and non-CDS materials for the relevant material category. An audit team sorted through the material each day using the five CDS material categories as per Table 3-2.

Table 3-2: Targeted Eligible Container Types

Materials		Container Types	Section
Glass		All beverages 150mL – less than 3L including: • Soft drinks; • Spring/mineral water; • Beer bottles; • Non grape – rice wine, plum wine, etc; • Sake; • Mixed drinks; • Cider; • Any beverage that contains spirits plus additional beverages, ingredients or flavours, including alcopops, ready to drink alcoholic beverages (RTDs), and • Fruit/vegetable juice and flavoured milk bottles; 150 ml – less than 1L.	• MRF • Kerbside • Bottle Crushers
Plastic	**PET**	150mL – less than 3L: • Water; • Flavoured milk drinks; • Sports drinks; • Soft drinks; • Other drink containers; • Any beverage that contains spirits plus additional beverages, ingredients or flavours including alcopops, ready to drink alcoholic beverages (RTDs) and spirit/liquor bottles less than 250mL (wine), 150ml – less than 1L: • Flavoured milk drinks and • Juices.	• MRF • Kerbside
	HDPE		
	Mixed Plastic		

Aluminium		150mL – less than 3L:
		• Aluminium beverage containers:
		  ○ Beer;
		  ○ Soft drink; and
		  ○ Others.
			• MRF
			• Kerbside
			• Metal Recyclers

Steel		150mL – less than 3L:
		• Steel beverage containers:
		  ○ Beer;
		  ○ Soft drink; and
		  ○ Others.
			• Kerbside
			• Metal Recyclers

Liquid Paperboard		150mL – less than 1L: • Milk – flavoured including: ○ Cows or other animal milk;	• Kerbside

Materials	Container Types	Section
	○ Soy or other plant-based milk; ○ Low fat milk; and ○ Ultra-heat-treated (UHT) milk. • Juices; • Energy drinks 150mL – less than 3L; and Other beverage containers	
Aseptic packs	All beverages 150mL – less than 3L except: • Wine 150mL – less than 1L; • Wine based beverage 150ml – less than 1L; • Water 150mL – less than 1L; • Juice (including coconut water); and Flavoured and UHT Milk 150mL – less than 1L.	• Kerbside
Sachets	All beverages 150mL – 3L except: • Juice, flavoured milk and water 150mL – less than 1L; and Wine 150mL – less than 250mL.	• Kerbside

Containers shown in Table 3-3 are **not** included as part of the works.

Table 3-3: Containers Not Included

Materials	Container types
Any beverage - concentrated fruit or vegetable juice (or a mixture of concentrated fruit or vegetable juices) that are intended to be diluted	All containers less than 150ml All containers 3L or more
Cordial – concentrated/undiluted	All containers
Fruit juice – pure (over 90% juice including reconstituted juice)	All containers 1L or more
Health tonics – registered	All containers
Milk – plain unflavoured	All containers
Milk – flavoured	All containers 1L or more
Vegetable juice – pure	All containers 1L or more
Spirits (alcohol)	In glass
Water – cask or aseptic pack	All containers 1L or more
Wine – cask	All containers 1L or more
Wine – sachets	All sachets less than 150mL All sachets more than 250mL

The sorted material was placed in a bucket or bin with the volume of each container recorded and then the container weighed using a digital platform weight scale with 0.01 kg precision up to 150 kg +/- 1% of true weight. CDS eligible containers were then counted.

The counts, weights and volumes were recorded onto data log sheet. The weight and volume of the non-CDS material was also recorded. The tare weights of sorted containers were verified at the start of each audit day to maintain accuracy.

Once the physical sorting was completed the sorting area was returned to a pre-audit state. The post-sort recyclable material was transported by the MRF staff to the tipping floor.

3.1.2.1 MRF Glass audits

Glass was audited by counting eligible containers on the basis of whole bottles, bottle necks, contaminants in the glass stream and a weight of the remaining glass fines at the kerbside and regional MRFs.

This was not able to be determined at the metropolitan MRFs due to breakage during collection and processing. Therefore the proportion of CDS eligible containers presented in the kerbside glass stream was applied at the metropolitan MRFs. The key issue to determine from the metropolitan MRF glass audits was the amount of contamination in the glass stream that needed to be deducted. This was factored in to calculating the EC/Kg value.

Glass samples from the metropolitan MRFs were taken in 10L sample units. All samples were taken at the MRF from the glass storage bunkers (and off the conveyor belt at Cleanaway South Guildford MRF). The sample units were weighed, with the tared weight of the container removed. The sample material was screened to assist with identifying any contaminants. Contaminants were removed and weighed, with the weight of the contaminants deducted from the total glass sample weight.

At regional MRFs three 240L samples of glass were collected and sorted.

3.2 Metal Recyclers

Talis liaised with the three end-point metal recyclers: Sims Metal Management, CD Dodd Scrap Metal Recyclers and Australian Consolidated Metals and Machinery, including a site visit at two of their facilities.

Talis also conducted a phone survey of 15 randomly selected metal recyclers across the state to identify if they receive aluminium containers, and whether they were able to quantify and or provide information on the amount of material they receive. Eight of the 15 contacted were willing to share data. Talis identified that they mostly send containers to the same metal recyclers therefore their tonnage has not been considered further. Results have been presented in Metal recycling results, refer Section 7.

3.3 Bottle crushers

Talis contacted the main companies that provide bottle crushing equipment to determine any locations within WA that have bottle crushing units in an attempt to quantify the amount of glass material throughput for each machine.

Data was only available from a small number of sites as the majority of glass crushing units are with facility management companies or mine-sites and Talis were not able to identify their location, or the

throughput from each unit. If located at mine sites it appeared that some of the material was being used in road base. Bottle Crusher companies collect the glass from the sites they service and send it to Adelaide for use in glass bottle manufacturing. Further detail on the data collected on bottle crushing is provided in Glass recyclers results, refer Section 8.

3.4 LGA Kerbside Audit

3.4.1 Sample Collection

Ten LGAs, 4 regional and 6 metropolitan were audited. LGAs were randomly selected from within five demographic clusters to provide a total sample that would be representative of the State. In addition, one council opted to do their own audit, at their own cost and approved use of their results in this audit report. Each LGA kerbside audit was conducted on one day, using a sample size of 100 households. The selected LGAs are shown in Table 3-4.

More detail on the method used to select the LGAs is shown in the Project Execution Plan separately provided to DWER.

Table 3-4: Selected LGAs

LGA	Region	Processing Location	Tonnage	Dwellings	Stratum
Claremont, Town of	Perth/Peel	Suez	1377	3806	Metro_1
Fremantle, City of	Perth/Peel	SMRC	3544	11498	Metro_1
Joondalup, City of	Perth/Peel	Cleanaway - South Guildford	16430	53810	Metro_2
Serpentine-Jarrahdale, Shire of	Perth/Peel	Cleanaway - South Guildford	2352	8387	Metro_2
Stirling, City of	Perth/Peel	Suez	22244	81402	Metro_3
Wanneroo, City of	Perth/Peel	Cleanaway - South Guildford	17651	61471	Metro_3
Broome, Shire of	Kimberley	Broome	1415	5083	Regional_1
Busselton, City of	South West	Cleanaway (Bunbury)	4413	12976	Regional _2
Esperance, Shire of	Goldfields	Esperance	1409	4802	Regional_2
Toodyay, Shire of	Wheatbelt	Avon - York	337	1740	Regional_2
Swan, City of	Perth/Peel	Cleanaway - South Guildford	12079	50815	Metro_2

The audit day was nominated by Talis, to align with the kerbside collection days of the LGA, the proposed sorting days at the MRFs, and the practicality of moving around the State during the audit period.

Talis randomly selected 10 streets (and some reserves) based on the LGAs recycling collection zone on the nominated audit day. The list of streets was provided to the LGA and their collection contractor prior to the audit so that truck re-routing could occur to reduce the chance of the audit samples being collected as part of the regular collection prior to the sampling being undertaken.

A Talis auditor accompanied each sample collection truck to record, count and verify that 100 households was selected in each sample, and that only representative households, such as single dwellings rather than commercial bins, park bins, aged care facilities etc. were included in the audit sample.

As part of the sample of 100 households Talis ensured that a representative number of high density households were included in the audit. Where the selected LGA had more than 5% of the population that is high density the respective proportion will be collected as part of the audit sample. Table 3-5 shows that a total of 50 high density households were included across the entire sample of 1000 households including in the audit.

Table 3-5: Proportion of high density dwellings by selected LGA

LGA	Proportion of high density dwellings (%) Source: ABS Census 2016	No of high density dwellings included in the kerbside audit sample
Broome	4.0	0
Busselton	0.3	0
Claremont	27.5	26 (9 Mobile Garbage Bins (MGBs))
Esperance	1.4	0
Fremantle	11.8	12 (4 MGBs)
Joondalup	2.3	0
Serpentine-Jarrahdale	0.1	0
Stirling	8.9	12 (3 MGBs)
Swan	0.8	0
Toodyay	0	0
Wanneroo	0.2	0
Total		50

Talis collected an average of 10 MGBs from 10 streets in each LGA, except in Toodyay where 21 streets were included due to the large property sizes and smaller number of households per street.

3.4.2 Sample Sorting

The audit material was delivered to the waste sorting site by the collection contractor. The material was weighed as it entered the facility (if a weighbridge was available) to determine the total audit load weight. The material was tipped into a designated area.

Sorters separated material into the agreed material categories, as shown in **Appendix A**. Each material category was sorted into separate containers. The volume of each container was recorded. The container was then weighed separately using a digital scale. The weight scale was calibrated prior to and during the audit.

Following weighing, CDS eligible containers were counted and recorded, against its corresponding weight record and volume.

Once the physical sorting was completed each day, the sorting area was cleaned and returned to a pre-audit state.

3.5 Data Analysis and Reporting

Data collected during the physical sorting was collated into Microsoft Excel spreadsheets for analysis and graphical representation. Input data was checked by an independent staff member to ensure accuracy. Pink Lake Analytics then undertook further data quality assurance and data analysis.

In order to validly represent the State and regions, data collected from MRFs were weighted. The method for weighting was generalised regression estimation, so that weights were calibrated to meet benchmark annual tonnage data obtained from the MRFs.

An explicit non-response adjustment was carried out so that the weights of the responding regional MRFs were inflated to represent Warren Blackwood MRF in the estimates. The kerbside audit data were weighted using stratum-level benchmarks of occupied dwellings from 2016 Census data.

The analysis was carried out within the R statistical computing environment[1], using the weighting and variance estimation algorithms from the *survey*[2] package.

3.5.1 Data limitations

The audit was undertaken over 6 weeks with only one day of auditing at some LGA's and facilities. The results are taken to be typical and representative of annual recycling practices throughout state. There are a number of factors that affect the EC/kg values including:

- Seasonality
- Changes to operations within the MRFs including but not limited to:
  - Operating speeds of the conveyor belts;
  - Staffing levels at picking points;
  - Changes to sorting equipment – operation of, or investment in, optical sorters and other separation equipment;
  - Targeted commodity outputs based on customer requirements; and
  - Proportion and composition of commercial and industrial client material received.

[1] R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] T. Lumley (2019) "survey: analysis of complex survey samples". R package version 3.35-1.

4 Kerbside Audit Results

Figure 4-1 shows the average kerbside audit recycling composition by weight. It shows the main components are paper and cardboard 35.6%, glass 32.8% and the 'other' category. Other includes textiles, expanded polystyrene, contaminated paper, greenwaste and other bulky or composite household goods such as toys.

Bagged recyclables and containerised food and liquid are considered contaminants for the purposes of the audit, as the MRF's indicated that these materials would generally be rejected during the sorting process. Other contaminants included e-waste and hazardous waste.

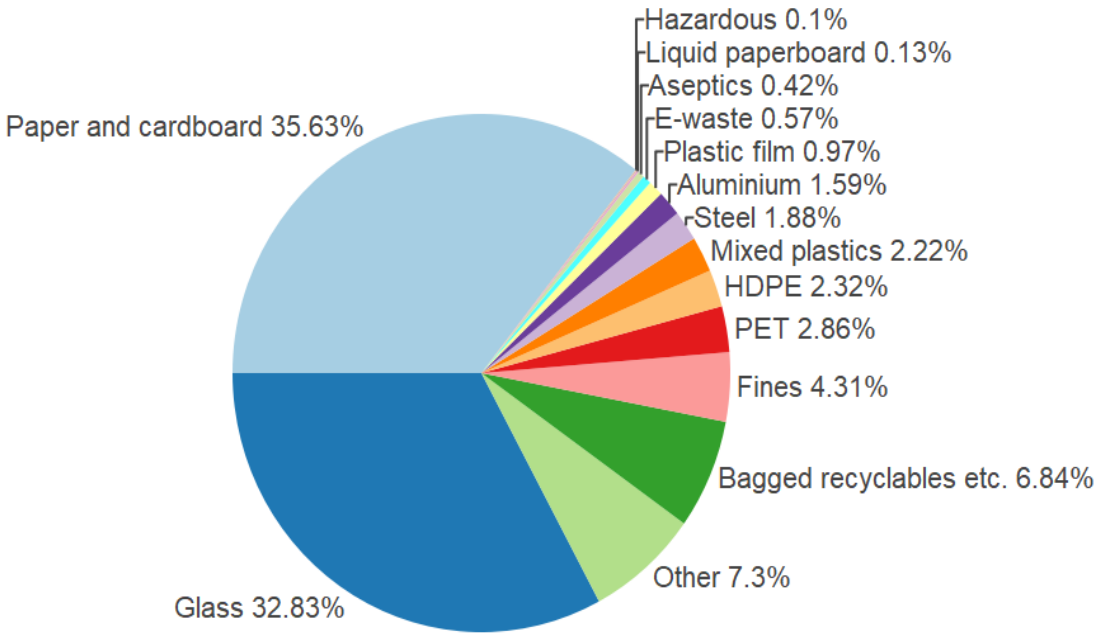

Figure 4-1: Average kerbside audit recycling composition – by weight

The detailed audit results percentage composition by weight are shown in Table 4-1. This shows that just over half the glass and PET is eligible, most of the aluminium is eligible and due to the large proportion of milk bottles very minimal HDPE is eligible.

The total contamination rate in the recycling stream is 20.1%, comprising plastic film, fines, bagged recyclables, containerised food and liquid, hazardous, e-waste, and other items such as textiles.

Table 4-1: Detailed audit results (% composition by weight)

Material Group	Eligible (%)	Non-CDS (%)	Total (%)
Aluminium	1.29	0.29	1.58
Aseptic packs and sachets	0.14	0.27	0.40
Bagged recyclables/ containerised food & liquid	-	6.84	6.84
E-waste	-	0.58	0.58
Fines	-	4.31	4.31
Glass	17.39	15.45	32.84
Hazardous	-	0.10	0.10
HDPE	0.07	2.27	2.34
Liquid paperboard	0.05	0.09	0.14
Mixed plastics	-	2.22	2.22
Other	-	7.30	7.30
Paper and cardboard	-	35.64	35.64
PET	1.74	1.13	2.87
Plastic film	-	0.96	0.96
Steel	-	1.88	1.88
Total	20.67	79.33	100.00

Figure 4-2 shows the proportion of paper and cardboard and glass differs significantly between LGAs with regional areas generally having a lower portion of paper and cardboard and higher portion of glass.

The proportion of contamination – particularly bagged recyclables/ containerised food and liquid, other non-recyclable items and fines varied significantly for each council. This is impacted by the LGA's education programs/ contamination management, as well as the area selected for the audit.

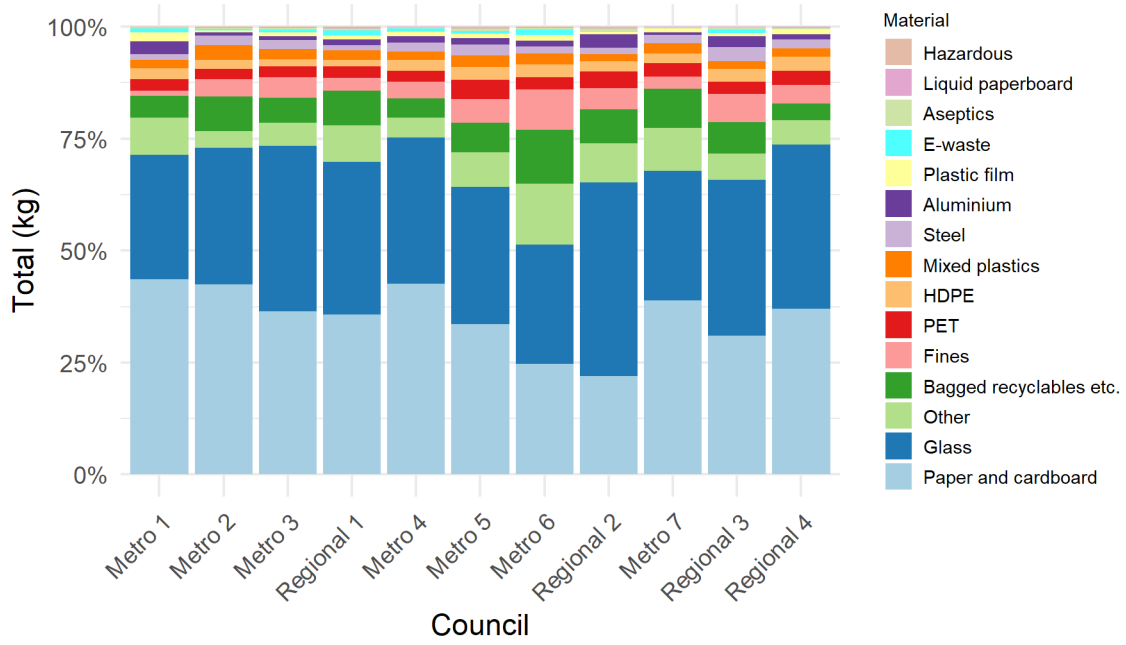

Figure 4-2 Comparison of kerbside audit composition (%)

The total sample for each LGA ranged between 818kg – 1169Kg. Figure 4-3 shows a comparison of the composition between each LGA by weight in Kg/household/fortnight using aggregated categories.

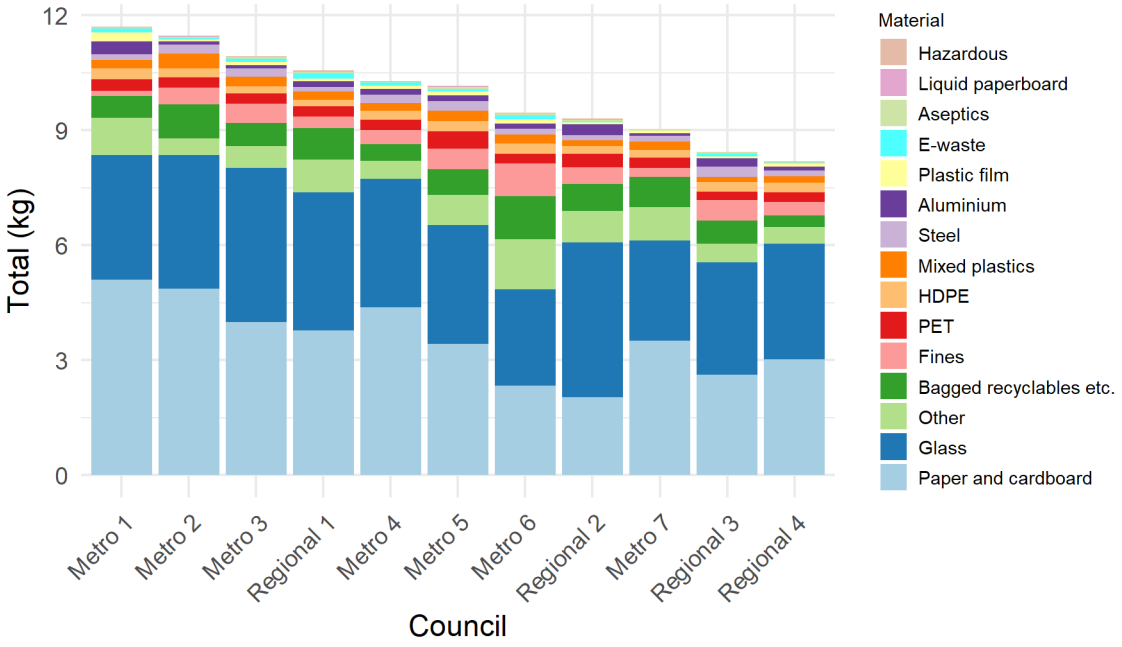

Figure 4-3 Comparison of kerbside audit composition (Kg/hhld/fortnight)

Figure 4-4 indicates that the Kg/household/fortnight of comingled recyclables sampled for each LGA under this audit is reasonably consistent with the average Kg/household of commingled recyclables collected as part the kerbside comingled recyclable collection service within each respective LGA for the year 2017/18. This is based on data reported by local governments to the annual Census of Western Australian Local Government Waste and Recycling Services (2017/18) and ABS 2016 Census data household numbers data.

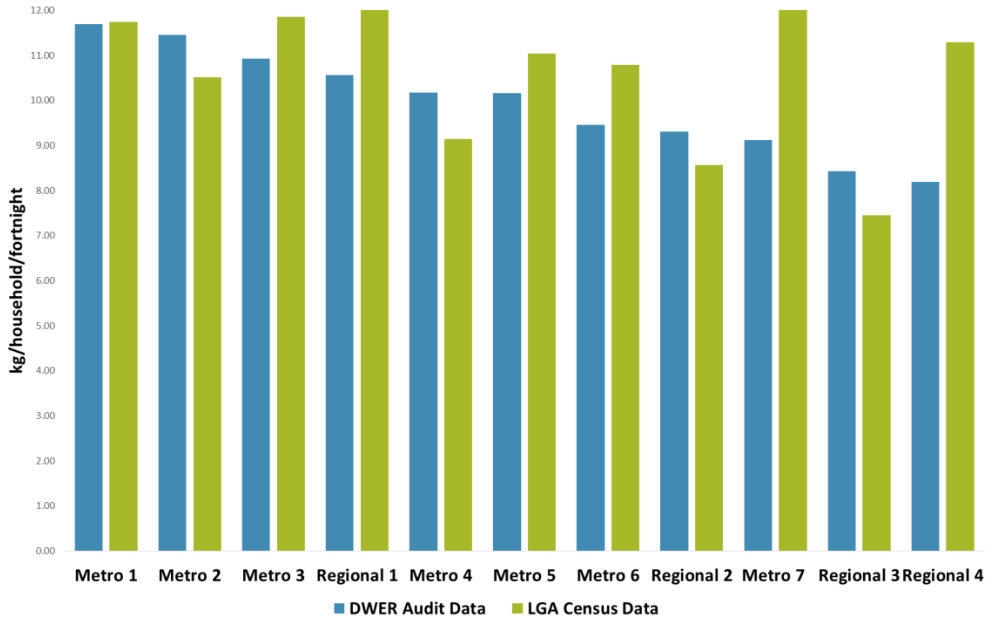

Figure 4-4 Comparison of kerbside comingled recyclables (Kg/hhld/fortnight)

Figure 4-5 shows the EC/Kg value by material type for each LGA, further detail is provided in Table 4-2 (following page). It shows that the aluminium EC/Kg value is significantly higher than any other material type, however aluminium makes up a very small percentage of the overall waste stream. Glass has a very low EC/Kg value but makes up a high proportion of the waste stream. It's important to note the EC/Kg values for liquid paperboard and aseptic packs and sachets, however these materials are currently not recycled at the MRFs.

The aluminium EC/Kg values are all similar except for Metro 1, which had some guttering in the sample which is an anomaly that has been excluded from further analysis; and Metro 7 which had a higher proportion of non-eligible aluminium such as foil trays, aerosols, cat food tins etc than the other LGAs.

The PET EC/Kg values varied between LGAs. This could be attributed to the size of eligible PET containers varying from 600mL to 2L containers which can cause a difference in the number of containers per kilogram.

Talis observed that individual household behaviour may influence the results for an LGA. For example if one household consumes a particularly large quantity of flavoured milk that may influence the EC/kg for HDPE or liquid paperboard. Additionally different demographic areas generate different ratios of eligible (beer bottles) versus non-eligible (wine bottles and jars) glass.

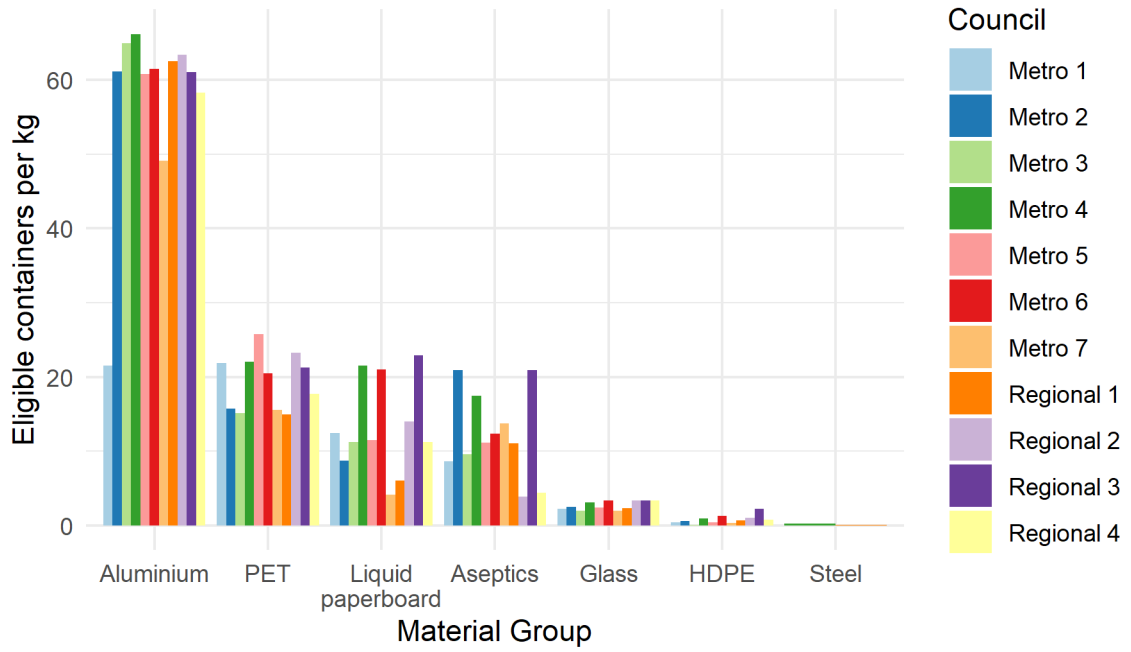

Figure 4-5: EC/Kg value for each LGA by material type.

Table 4-2 shows the EC/Kg value for each material and each LGA, along with summary statistics. The State level estimate is the result of sample weighting based on the stratified survey design and calibration of weights to population benchmarks. The weighting method gives an unbiased estimate of the EC/Kg value for the entire State.

Table 4-2: EC/Kg value by LGA by material type

Council	Glass	PET	HDPE	Aluminium	Steel	Liquid paperboard	Aseptic
Metro 1	2.20	21.89	0.38	21.57	0.00	12.41	8.61
Metro 2	2.50	15.74	0.56	61.16	0.00	8.70	20.91
Metro 3	1.98	15.09	0.11	64.98	0.00	11.26	9.63
Metro 4	3.13	22.03	0.98	66.20	0.24	21.55	17.44
Metro 5	2.42	25.79	0.39	60.78	0.00	11.51	11.11
Metro 6	3.36	20.48	1.28	61.53	0.00	20.97	12.34
Metro 7	2.01	15.52	0.31	49.12	0.00	4.11	13.77
Regional 1	2.33	14.95	0.70	62.52	0.08	6.03	11.05
Regional 2	3.36	23.29	1.00	63.43	0.00	14.00	3.92
Regional 3	3.40	21.27	2.24	61.02	0.00	22.89	20.89
Regional 4	3.35	17.75	0.73	58.29	0.00	11.25	4.40
LGA average	2.73	19.44	0.79	57.33	0.03	13.15	12.19
unweighted sample ECF	2.72	19.87	0.81	53.78	0.03	12.17	12.23
weighted sample ECF	2.63	20.63	0.70	61.84	0.03	12.66	13.32

It is also interesting to note the impact of steel container generation. Steel drinks containers were rarely observed and if they did occur they were likely to be generated by one particular household within the collection area.

The proportion generation for the State may be correct however at a LGA level the EC/Kg value may not be representative. Figures 4-6 to 4-8 below show photographic examples of this for steel cans, liquid paperboard and HDPE and the impact that one household may have on a LGA's EC/Kg value.

Figure 4-6: Examples of eligible steel cans

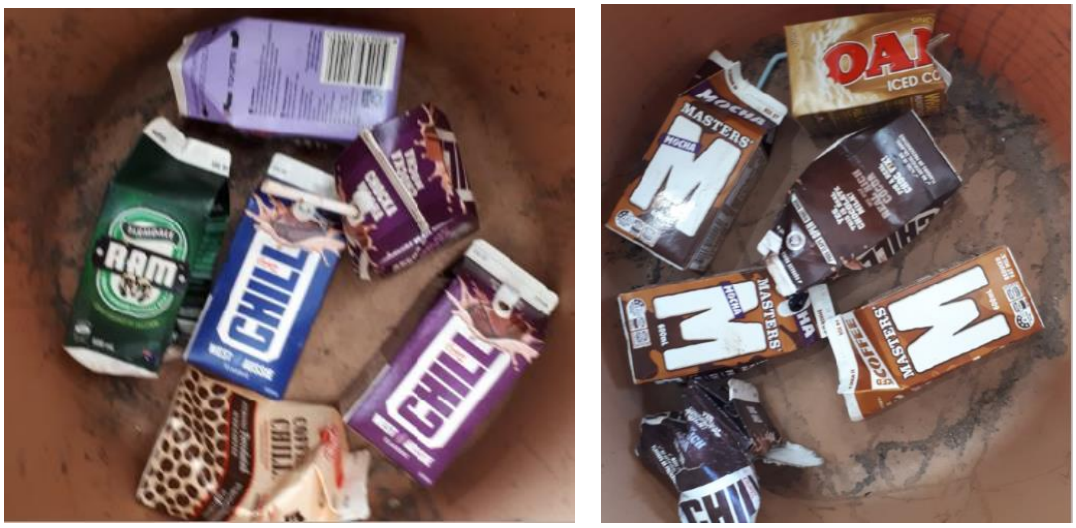

Figure 4-7: Examples of eligible liquid paperboard

Figure 4-8: Examples of eligible HDPE

5 MRF Audit Results

A summary of the audit results is shown in the following sections.

5.1 Comparison of MRF audit results

The EC/Kg value by MRF for each material type is shown in Figure 5-1. Regional MRF EC/Kgs are higher than the metropolitan MRF EC/Kgs for all container types as a result of hand sorting of the material resulting in low contamination rates.

Aluminium EC/Kg values are all very similar with the main difference being the amount of non-eligible cat food tins and trays identified in the samples. The glass EC/Kg values are also fairly similar as a result of the low number of eligible containers per kilogram, and the use of a standardised base EC/Kgs for each of the metropolitan MRFs. Mixed plastics were only considered at the metropolitan MRFs and one regional MRF. The composition, and therefore EC/kg, of mixed plastic varies at the metropolitan MRF's as a result of different belt speeds, MRF configurations and sorting equipment (e.g. different brands and settings for their optical sorters) that result in different proportions of PET and HDPE being captured.

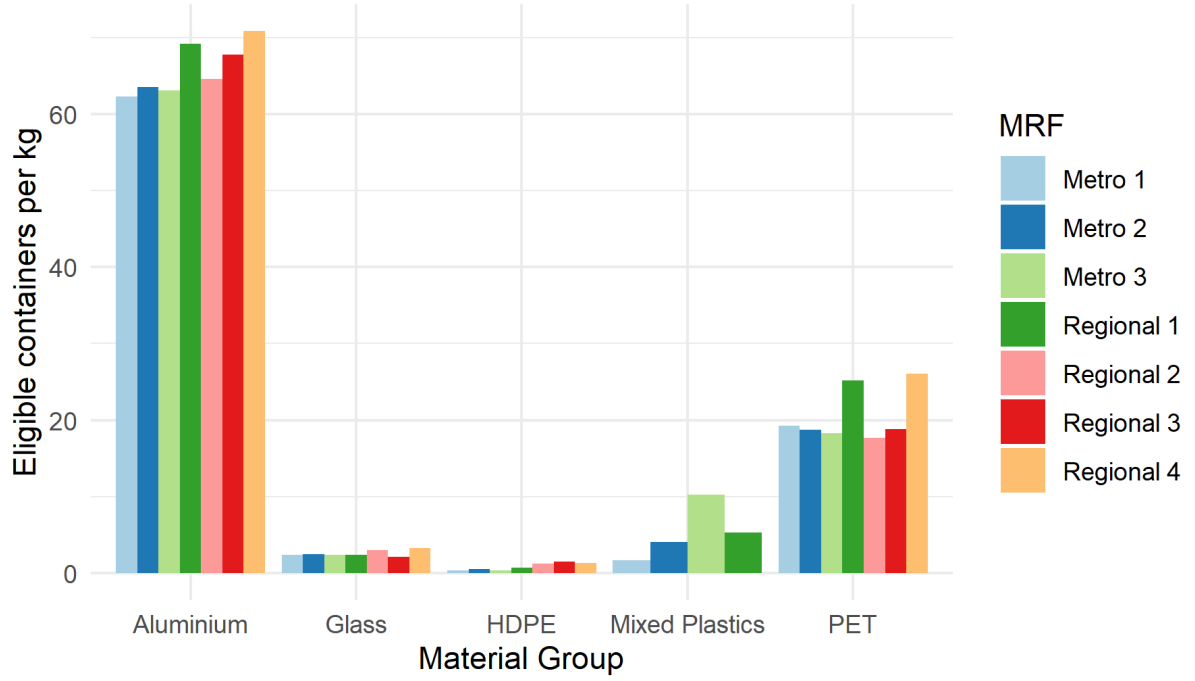

Figure 5-1: Eligible Container per kilogram by MRF

This is shown in actual numbers of containers per kilogram in Table 5-1.

Table 5-1: Eligible container per Kg by MRF

MRF	PET	HDPE	Mixed Plastics	Aluminium	Glass
Regional 1	25.14	0.72	5.31	69.24	2.35
Regional 2	17.68	1.22	-	64.64	2.99
Regional 3	18.77	1.47	-	67.85	2.08
Regional 4	26.02	1.26	-	70.87	3.28
Metro 1	19.22	0.36	1.63	62.33	2.33
Metro 2	18.72	0.53	4.02	63.52	2.43
Metro 3	18.32	0.36	10.19	63.13	2.34

6 Combined audit results and average EC/Kgs

The results in the previous section have been combined to provide a metropolitan EC/Kg value, regional EC/Kg value and statewide EC/Kg value.

The data confidence around each figure is also provided in the form of a 95% confidence interval. As shown in the previous charts the regional EC/Kgs are higher than the metropolitan EC/Kgs due to the hand sorting of material and therefore lower contamination rates. The State average is more heavily influenced by the metropolitan results as it is calculated as a weighted State average, refer Table 6-1.

Table 6-1: Average Eligible containers per kg recycling

Estimate	PET	HDPE	Mixed Plastics	Aluminium	Glass
Metro	18.88	0.37	4.11	62.61	2.34
Regional	22.60	1.04	5.31	68.24	2.78
State	19.13	0.42	4.12	63.12	2.35
C.I. metro	(18.25,19.51)	(0.32,0.43)	(3.50,4.71)	(61.11,64.10)	(2.10,2.59)
C.I. regional	(22.07,23.13)	(0.96,1.12)	(4.13,6.49)	(66.86,69.62)	(2.43,3.14)
C.I. state	(18.54,19.72)	(0.37,0.47)	(3.52,4.71)	(61.76,64.48)	(2.11,2.59)

6.1 Comparison between LGA and MRF EC/Kg values

Table 6-2 shows the LGA and MRF have similar EC/Kg values.

Table 6-2 LGA and MRF EC/Kg comparison

State EC/Kg	PET	HDPE	Mixed Plastics	Aluminium	Glass
LGA average	20.63	0.70	-	61.84	2.63
MRF average	19.13	0.42	4.12	63.12	2.35

- PET - The slight difference in PET can be accounted for in the mixed plastics stream at the MRF.
- HDPE - The difference in the HDPE can also be accounted for in the mixed plastics stream at the MRF. HDPE is likely to be in mixed plastics in a higher ratio than the PET as most of the eligible PET is clear plastic, most of the eligible HDPE is coloured plastic.
- Mixed plastics - There was no mixed plastics comparison other than PET and HDPE identified in the kerbside audits.
- Aluminium – the difference is related to the number of foil trays and alfoil identified in the LGA kerbside audit which is likely to be screened out with trommels at the metropolitan MRFs prior to reaching the eddy current separator.
- Glass – the LGA EC/Kg value has been used to calculate the MRF EC/Kg value which is inclusive of contamination.

7 Metal recycling results

Based on information from the MRFs and the metal recyclers, they exchange aluminium bales between the recyclers to optimise sending full containers for processing. The contamination rate of the bales sent for processing was minimal (<2%). Due to the minimal amount of eligible steel containers found during the audit period the metal recyclers were not requested to supply data on this material type.

Table 7-1 shows an estimate of the aluminium tonnes sent for recycling each year by the major metal recyclers in Perth.

Table 7-1: Eligible containers from metal recyclers

Location	Tonnes/year	Aluminium EC/Kg	No of containers
Total	340.5tpa	62.79	21,379,995

The EC/Kg value for aluminium is very high, and estimations of tonnages differed by over 50tpa (~3.1million containers).

8 Glass recyclers results

Approximately 1,153,846 containers per year are recycled through some Bottle Cycler units and one Bottle Crusher site. Information was not available for most sites because the bottle crusher provider has no ongoing servicing arrangement so it's not clear where the units are located and whether they are still in operation, or the organisation using the unit has not kept a record of containers recycled.

Some of the organisations that purchase the bottle crushing units are facility management companies that may take the unit with them as they change contracts

The results show significant potential to recover containers through hotels, pubs and restaurants, however it was not part of this scope of works to identify what proportion of the hospitality industry currently uses recycling service.

Each mine-site camp has a potentially large impact on the overall recovery rate with one mine site recovering 1 million containers per year. Talis were not able to identify specific mine sites with bottle crushers to try to quantify the number of containers purchased or recycled.

9 Total number of eligible containers currently recycled

A key output for this study is how the eligible containers per kilogram convert to provide a total number of containers currently recycled in the State. Talis has calculated this baseline number of containers using a few different contributing factors. The total tonnes of each target material were taken from historical data provided by the metropolitan and regional MRFs for 2018/2019.

9.1 Total number of eligible containers based on the MRF EC/Kg value

Table 9-1 shows the number of containers calculated by applying the state-wide EC/Kg value (Table 6-1), multiplied by the total MRF tonnages.

Table 9-1: Total number of eligible containers based on the state-wide EC/kg value

Material	EC/Kg	Tonnes	Total number of containers	Total value (10c/container)
PET	19.13	4,142	79,230,721	$7,923,072
HDPE	0.42	3,904	1,639,827	$163,983
Mixed Plastics	4.12	4,928	20,303,854	$2,030,385
Aluminium	63.12	2,008	126,750,641	$12,675,064
Glass	2.35	79,731	187,368,108	$18,736,811
Total		94,713	415,293,152	$41,529,315

Table 9-2 shows results where a separate EC/Kg value is used for the regional MRFs and the metropolitan MRFs (Table 6-1) to calculate the number of containers. The EC/Kg value shown in this table is an implied value, calculated from the estimated number of containers and the total tonnage.

Table 9-2: Total number of eligible containers based on the metro/regional EC/kg as appropriate

Material	Metro EC/Kg	Regional EC/Kg	Tonnes	Total number of containers	Total value (10c/container)
PET	18.88	22.6	4,142	79,244,336	$7,924,434
HDPE	0.37	1.04	3,904	1,626,180	$162,618
Mixed Plastics	4.11	5.31	4,928	20,315,773	$2,031,577
Aluminium	62.61	68.24	2,008	126,756,805	$12,675,680
Glass	2.34	2.78	79,731	187,517,677	$18,751,768
Total			94,713	415,460,771	$41,546,077

The values in Table 9-3 have been calculated based on the EC/Kg value for the 8 individual MRFs multiplied by the MRF tonnage throughput for 2018/19. The single EC/Kg value shown in this table is an implied state-wide value, calculated by dividing the estimated number of containers by the State tonnage total.

Table 9-3: Total number of eligible containers based on MRF EC/Kg value

Material	EC/Kg	Tonnes	Total number of containers	Total value (10c/container)
PET	19.11	4,142	79,161,338	$7,916,134
HDPE	0.42	3,904	1,626,364	$162,636
Mixed Plastics	4.11	4,928	20,239,156	$2,023,916
Aluminium	63.22	2,008	126,949,664	$12,694,966
Glass	2.35	79,731	187,592,683	$18,759,268
Total		94,713	415,569,205	$41,556,920

Note, the total number of containers calculated are based on exact values from 8 separate facilities (with multiple decimal places) therefore it is an implied EC/Kg.

The state-wide, metropolitan/regional or calculation by 8 separate facilities produce almost identical results as the weighting is calibrated to tonnage benchmarks. The approach of applying an estimate of eligible containers per kilogram of recycling estimated separately for regional and metropolitan MRFs has been used as the baseline for the remainder of the report.

9.2 Total number of eligible containers including metal and bottle recyclers

As discussed in Section 7 Metal Recyclers, there are approximately 21.4 to 25 million aluminium containers being recycled in addition to the MRF recycling**.** Glass recycling has not been well quantified but is at least an additional 1.1 million containers. These totals could be added to the total number of containers recycled in the State bringing the total closer to 427 million containers being recovered in the State.

10 Discussion of results

WARRRL have indicated that approximately 1.3 billion eligible containers were sold in the State in 2018/19. Using the results from the baseline audit 415.5 million containers are recovered through MRFs giving a recovery rate of 32% of all containers sold in the State. With the addition of metal recyclers and glass recyclers, an additional 1.6% is recovered. Bringing the total recovery rate to 33.6%.

Talis have looked at the capture rates of recyclables from households. Based on the audit results the average household presents 11.9 CDS eligible containers in their recycling bin per week, and 5.2 containers in their general waste bin[3]. This indicates a capture rate of 70% of CDS eligible containers from households.

The capture rates of CDS eligible materials generated in households are relatively high. Therefore it is likely that a significant portion of the 66% CDS eligible containers not accounted for in the report are from non-household sources.

Seventeen per cent (17.3%) of the recyclables received at the metropolitan MRFs in 2017/18 were from commercial and industrial sources – including offices, schools, mine sites, event and hospitality venues. However there is significant potential to recover more recyclables from the following sources:

- Mine sites;
- Hospitality sector (hotels, restaurants, bars and cafes);
- Institutions (hospitals, airports, schools other government buildings);
- Other commercial & industrial sources (e.g. offices, retail & trade); and
- Events, public bins and litter.

The baseline audit results provide a robust indication of the number of CDS eligible containers which were being recycled in the State through MRFs in 2018/19. However since that time there was a devastating fire at Cleanaway's South Guildford MRF which was taking 55% of WA's recyclables. It is unlikely that the MRF will be rebuilt by the time the CDS commences. Therefore the assumed eligible containers per kg for the State will change, as would the number of eligible containers being recycled in 2019/20. The fluctuations in the recycling market impact the initial recommendations about ongoing auditing until the recycling market in WA stabilises.

[3] *Source: EMRC Waste Audit (Feb 2020) https://www.emrc.org.au/documents/819/emrc-waste-audit-presentation*

Appendix A: Waste Sorting Categories

Waste Sorting Categories

Material Group	CDS categorisation	WCS number	Description
Glass	CDS eligible	D01	150mL to 3L beverages including soft drinks, fruit/vegetable juice bottles, spring/mineral water, beer bottles, plum wine, sake, mixed drinks, cider and any beverage that contains spirits plus additional beverages, ingredients or flavours, including alcopops, ready to drink alcoholic beverages (RTDs).
Glass	Non-CDS	D01 –D02, D05	Wine bottles, jars and bottles for sauces and other condiments, non-beverage glass
PET	CDS eligible	E01	150mL to 3L - Water, flavoured milk drinks, sports drinks, soft drinks, juices, other drink containers and any beverage that contains spirits plus additional beverages, ingredients or flavours including alcopops, ready to drink alcoholic beverages (RTDs) and spirit/liquor bottles less than 250mL (wine).
PET	Non-CDS	E01	PET trays, cups and other non-CDS eligible PET containers. Cordial bottles, pure or concentrated fruit juice. Water bottles, flavoured milk or pure vegetable/juice containers more than 1Lt
HDPE	CDS eligible	E02	150mL to 3L - Water, flavoured milk drinks, sports drinks, soft drinks, juices, other drink containers and any beverage that contains spirits plus additional beverages, ingredients or flavours including alcopops, ready to drink alcoholic beverages (RTDs) and spirit/liquor bottles less than 250mL (wine).
HDPE	Non-CDS	E02	Milk bottles, HDPE trays, cups and other non-CDS eligible HDPE containers, cordial bottles, pure or concentrated fruit juice. Water bottles, flavoured milk or pure vegetable/juice containers more than 1Lt
Mixed Plastics	CDS eligible	E03-E06	150mL to 3L - Water, flavoured milk drinks, sports drinks, soft drinks, juices, other drink containers and any beverage that contains spirits plus additional beverages, ingredients or flavours including alcopops, ready to drink alcoholic beverages (RTDs) and spirit/liquor bottles less than 250mL (wine).
Mixed Plastics	Non-CDS	E03-E06	Non-CDS containers, Cordial bottles, pure or concentrated fruit juice. Water bottles, flavoured milk or pure vegetable/juice containers more than 1Lt
Plastic film	Non-CDS	E02-E06	Dry cleaning bags, plastic sheeting, packaging film and sheeting, potato chip bags, bread bags and plastic bags
Aluminium	CDS eligible	F01	150mL to 3L - aluminium beverage containers - beer, soft drinks and others.
Aluminium	Non-CDS	F01	Aluminium foil, trays, pet food packs and other non-CDS eligible containers
Steel	CDS eligible	G01	150ml to 3L - steel beverage containers - beer, soft drinks and others.
Steel	Non-CDS	G01	Aerosol cans, other steel and non-CDS containers
Liquid paperboard	CDS eligible	A06	150mL to 1L - Milk – flavoured including cow's or other animal milk, soy or other plant-based milk, low fat milk, ultra-heat-treated (UHT) milk, juices and energy drinks.

Material Group	CDS categorisation	WCS number	Description
Liquid paperboard	Non-CDS	A06	Plain, unflavored milk (animal and plant based)
Aseptic packs and sachets	CDS eligible		UHT aseptic containers - all beverages 150ml to 3L except wine (150ml to 250mL), wine based beverage (150ml – 1L), water (150mL to 1L), juice and flavoured milk (150ml to 1L)
Aseptic packs and sachets	Non-CDS		All other non-CDS aseptic containers and sachets including plain and unflavoured milk (animal and plant based)
Paper and Cardboard - Recyclable	Non-CDS	A01-A08	Newspaper, Magazines/brochures, Corrugated cardboard, Cardboard packaging board, Paper (non-glossy)
Fines (<20mm)	Non-CDS		Ceramics, rock, soil, ash, bottle tops, plastic flakes
Bagged recyclables /containerised food & liquid	Non-CDS		Material presented in tied bags, food or liquid in containers where the weight of the food or liquid is heavier than the container
Hazardous	Non-CDS	H01-H07, C05	All battery types, fluorescent tubes, medical waste (including medication), human tissue, blood stained disposable material, gas bottles, chemicals (bleach, shampoo, cleaning products) paints, motor oil, toner cartridges
E-waste	Non-CDS		Computer equipment, mobiles, speakers, cabling
Other	Non-CDS	A09, A90, A92, B01-B03, C01-C04	Compostable paper (tissues/handtowel), coffee cups, polystyrene, composite products, nappies, food, garden waste, garden hose, cooking utensils (pots/pans), broken crockery, , Other organics –wood, textile/rags/ cloths, leather & rubber, Wool, cotton natural fibre materials, some shoes, belts with buckle, rubber bands, rubber toys, shoes latex gloves, pillows, carpet

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