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Kerbside arisings by household type

Findings

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Overview of approach

1. Obtain raw data kerbside arisings & composition - WCA study data mining
2. Postcode conversion of data
3. Analysis of appropriate housing sub-groups
4. Collect additional background data e.g. bulk density factors, recognition rates
5. Develop model and quality review
6. Further analysis of: housing sub-groups; per capita arisings & composition
7. Model scenarios based on arisings for housing sub-groups

Raw data

- ZWS WCA Fund 2013-15:
  - 18 studies (70% hhs)
  - Range of LAs & recycling types
  - Residual & recycling sorted
- Data:
  - Arisings by stratum (50 hhs)
  - Complete data strata only i.e. recycling + residual
- Information added:
  - OAC 2011
  - Urban/rural
  - SIMD
  - Property type (using OAC)

Housing sub-groups

- Proposed:
  - Kerbside access
  - Non-kerbside access (including flats, tenements & high-rise)
  - Ultra-rural (including Islands)
- Final groups:

Rural

Suburban

Urban

Constrained / Hard pressed

Flats

Own-door

Flats

Housing sub-groups

- Not enough data to support an ultra-rural group
- Differentiation in groups useful for describing variation in arisings BUT
  - Data on rural v. limited – low confidence in results
  - Data on flats limited – based largely on Glasgow & Edinburgh data
- Own-door & flats used for capacity results – otherwise too many results to capture in CoP

Estimated people per household

Group	Corresponding / best fit OAC 2011 supergroup	Households	Population	Pop/hh
Rural	1	271,102	645,691	2.38
Urban	5	263,581	603,900	2.29
Suburban	6	424,364	109,9521	2.59
Constrained / Hard pressed	7&8	1,145,492	2,413,989	2.11
	All OAC supergroups	2,372,777	5,295,403	2.23
	Median LA household estimate			2.21

Assumptions: bulk density factors

- Range of densities in published reports from different sources e.g. WRAP/EA
- Densities vary due to
  - Different containers
  - Varying nature of waste streams
- Analysis has generally used WRAP bulk density report – observed figures
- Sensitivity analysis conducted around factors with greatest uncertainty and/or impact i.e. residual

Assumptions: bulk density factors

Stream	Container	Factor used in modelling	Other sources	Justification
Food waste	23l caddy	0.29 (WRAP bulk density)	0.2 (EA) 0.38 (WRAP Hospitality) 0.34 (Moray) 0.55 (KAT)	Large observed sample
DMR with glass	240l bin	0.08 (WRAP bulk density)	0.07 (SAC WCA results)	WRAP & WCA similar
DMR no glass	240l bin	0.05 (WRAP bulk density)	0.2 (PKC report) 0.06 (Moray WCA results)	WRAP observed figure aligns with Moray observed figure. PKC figure calculated.
Residual waste	240l bin	0.11 (WRAP Hospitality / WCA observed average)	0.08 (WRAP apportionment tool) 0.26 (EA) 0.33 (PKC report) 0.33 (KAT)	Alignment of WRAP Hospitality and WCA observed; however, sensitivity analysis to understand impact

Assumptions: bulk density factors

Stream	Container	Factor used in modelling	Other sources	Justification
Glass	Box	0.28 (WRAP bulk density)	0.33 (EA)	More recent, large observed
Mixed paper & card	140l/240l bin	0.11 (WRAP bulk density)	0.12 (Hospitality sector) 0.07 (WRAP apportionment tool) 0.21 (EA)	Observed. More uncertainty around this factor. May need sensitivity analysis
Mixed cans	Box	0.04 (WRAP bulk density)		Observed & only available
Mixed plastics	Box	0.02 (WRAP bulk density)	0.04 (WRAP LA apportionment tool) 0.14 (EA)	Observed

Assumptions: arisings / composition

Arisings level	Values for individual materials	Total arisings	% composition
Median	Median sample value	Sum of median values	(Median value of material) / (Sum of median values)
Q3 (75% households)	Q3 sample value (75% line)	Sum of Q3 values	(Q3 value of material) / (Sum of Q3 values)
(Max – not presented in results)	Max sample value	Sum of max values	(Max value of material) / (Sum of max values)
Max observed	% comp. applied to maximum observed value	Maximum observed value from samples (kerbside glass hhs only)	Q3 % composition

Arisings for each material calculated individually based on available data – able to capture variation by material

Assumptions: recognition rates
Capture rates vs. recognition rate

- Aim of study is to identify container required for **participating** households
- Capture rates = quantity of target material 'captured' by **recycling scheme (all households served)** divided by the total quantity of that type of material present
- Recognition rate = quantity of target material 'captured' by **participating households** divided by the total quantity of that type of material present at participating households only
- Recognition rate is the relevant metric to use in determining container capacities
- BUT less data available on recognition rate as requires data capture per household - expensive

Assumptions: recognition rate

Material	Current high performing household (literature review and WCA results)	Future high performing household (50% increase in performance with 95% maximum)
Packaging glass - clear	90%	95%
Packaging glass - other	95%	95%
Newspaper, magazines, other recyclable paper	90%	95%
Corrugated cardboard	95%	95%
Non-corrugated cardboard, Cardboard beverage packaging / cartons	75%	93%
Metal cans	75%	93%
Metal aerosols	50%	75%
Aluminum packaging	20%	60%
Plastic bottles	80%	90%
Dense plastic packaging excl. EPS	45%	73%
Food waste	95%	95%

Scenarios: collection system

	Container 1	Container 2	Other containers
Fully co-mingled	DMR	**-**	-
Co-mingled, separate glass	DMR	**Glass**	-
Twin stream	Fibres	**Glass, plastics, metals**	-
Fully segregated	Card	**Paper**	1. Plastic 2. Glass 3. Metal

Materials collected at kerbside:
Packaging glass
Newspaper, magazines, other recyclable paper
Corrugated cardboard
Non-corrugated cardboard
Cardboard beverage packaging / cartons
Metal cans
Metal aerosols
Aluminium packaging
Plastic bottles
Dense plastic packaging excl. EPS
Food waste

Scenarios: contamination

Level	%	Source
Low	0%	Ideal
Medium	5%	In line with source segregated contamination findings (although average individual material contamination rates varied considerably)
High	15%	WCA studies

Where contamination greater than 0% it has been assumed that container capacity has to be provided in BOTH the residual AND the recycling containers for this material.

Results: arisings per capita estimates

- 5.51 kg/capita/wk (WCA LAs)
- 5.67 kg/capita/wk (WCA LAs collecting glass at kerbside)
- 5.26 kg/capita/wk (estimate from WDF 2013 Scottish LAs)
- 5.86 kg/capita/wk (England 2013)

Results – arisings per capita estimates

- 5.67 = average arisings per capita (where glass collected at kerbside)
- NB hhs with fewer inhabitants widely thought to create more waste per capita than larger households i.e. 5.67 kg/cap/wk will not be representative of all households

Property type	Arisings level	Arisings (kg/hh/wk)	Est. av. no. of inhabitants
Own-door	Median	13.55	2.39
Own-door	Q3	15.79	2.78
Own-door	Max. observed	18.55	3.27
Flats	Mean	8.94	1.58
Flats	Q3	10.76	1.90
Flats	Max. observed	15.61	2.75

- **NB Flat figures are based on a very small dataset and hence greater uncertainty around results**

Results: total arisings by group

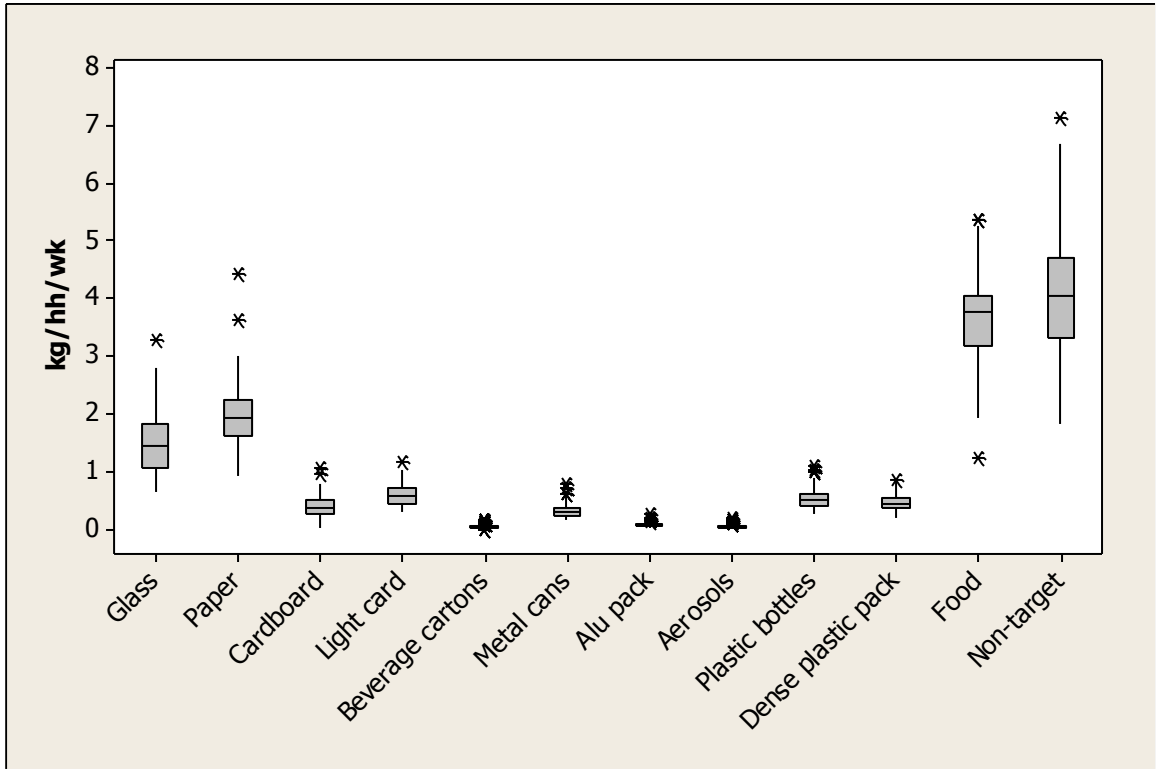
	kg/hh/wk – median (*Flats: mean*)	kg/hh/wk – Q3 (75% of households)	kg/hh/wk – max. observed	Average no. people/hhs – samples used	Average no. people/hhs – best fit OAC supergroup
Rural	11.47	13.72	11.90	2.43 (2.17 glass samples)	2.38
Urban	12.94	15.55	16.50	2.33 (2.50 glass samples)	2.29
Suburban	13.82	16.24	18.55	2.59 (2.68 glass samples)	2.59
Constrained/Hard pressed	13.86	16.21	18.00	2.28 (2.36 glass samples)	2.11
All own-door	13.55	15.79	18.55	2.41 (2.45 glass samples)	
Own-door (Constrained/Hard-pressed & Suburban only)	13.83	15.95	18.55	2.42 (2.47 glass samples)	
Flats	*8.94*	*10.76*	*15.61*	*1.96 (2.29 glass samples)*	

Results: composition by group (median values i.e. typical household)

	Packaging glass	News, pams, other recyclable paper	Corrugated cardboard	Non-corrugated cardboard	Cardboard beverage packaging / cartons	Metal cans	Al. packaging	Metal aerosols	Plastic bottles	Dense plastic packaging exc. EPS	Food waste - recyclable	Non-target
Urban	9%	13%	3%	5%	0.4%	2%	1%	0.4%	4%	4%	29%	30%
Suburban	12%	15%	3%	4%	0.4%	2%	1%	0.3%	3%	4%	28%	27%
Const./H.P	9%	13%	3%	4%	0.3%	3%	0.5%	0.4%	4%	3%	28%	32%
All own-door	11%	14%	3%	4%	0.3%	2%	0.5%	0.3%	4%	3%	28%	30%
Flats (mean)	10%	11%	3%	6%	0.4%	3%	1%	0.4%	5%	4%	26%	32%

- Most variation in groups relates to glass, paper, food and non-target materials
- Results for Urban group should be used with caution – very small sample

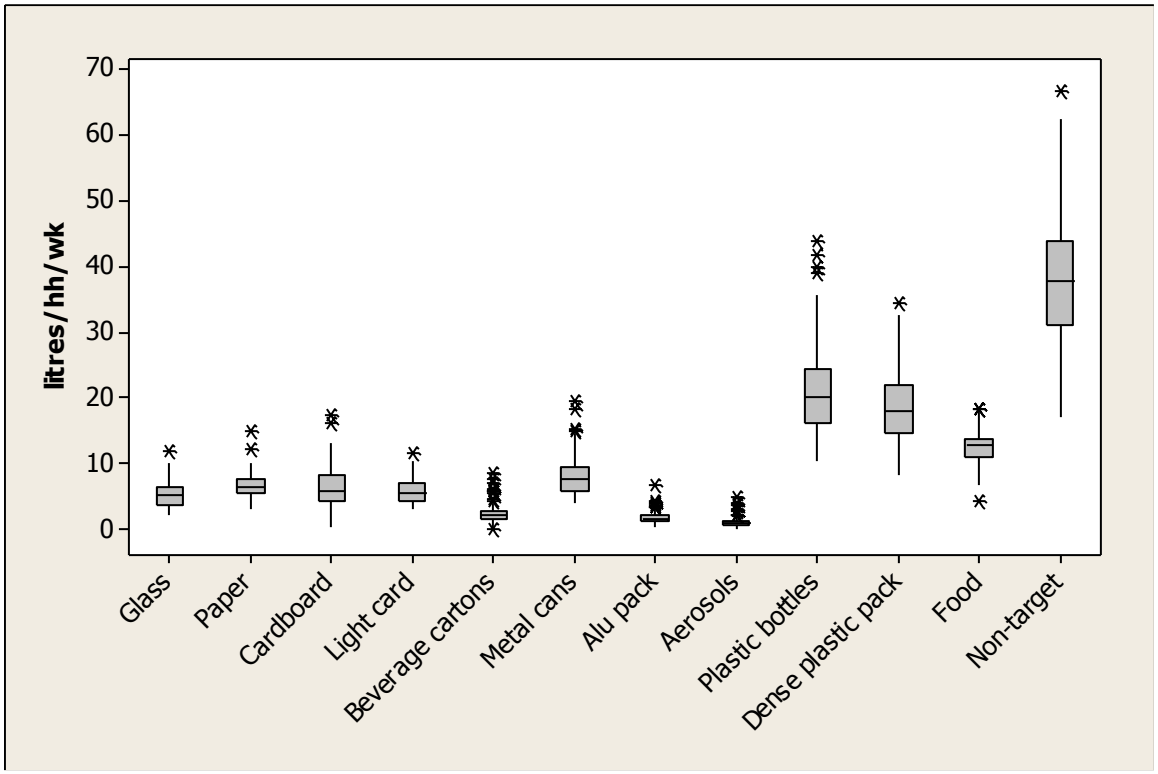
Results: variation by material – own door kg/hh/wk



High variation in:

- Glass
- Paper
- Food
- Non-target

Results: variation by material – indicative own door litres/hh/wk



When converted to volume:

- glass, paper and food have less effect on capacity
- Plastics and non-target have more impact

NB Exact impact of plastics and non-target will depend greatly on chosen bulk density conversion factors

Results: yield per participating household – own-door

	Packaging glass	News, pams, other recyclable paper	Corrugated cardboard	Non-corrugated cardboard	Cardboard beverage packaging / cartons	Metal cans	Al. packaging	Metal aerosols	Plastic bottles	Dense plastic packaging exc. EPS	Food waste - recyclable
Median arisings (kg/hh/wk)	1.45	1.94	0.36	0.56	0.05	0.31	0.07	0.04	0.50	0.45	3.78
Median observed yield per participating household (kg/hh/wk)	1.87	1.85	0.36	0.44	0.03	0.22	0.01	0.02	0.40	0.16	3.10
Potential recycling capacity shortfall	0.43	-0.08	-0.01	-0.13	-0.01	-0.09	-0.06	-0.02	-0.11	-0.29	-0.68

Results: yield per participating household – own-door cont…

- Data suggests glass yields very variable
  - Suggests additional glass capacity
- Max. observed yields/participating hh for many materials exceed the predicated max. observed arisings
  - Suggests spikes in material yield
  - Paper, corrugated card, plastic bottles
  - Planned capacity won’t always be enough

Results: container capacity – *residual*

- A full 140 litre bin would weigh:
  - 15kg using 0.11 bulk density factor
  - 46kg using 0.33 bulk density factor

Average household – own-door l/hh/wk		**1 week**	**2-week**	**3-week**	**4-week**	**5-week**	**6-week**
Current	**0.11 bulk density**	48.5	97.0	145.5	194.0	242.4	290.9
	0.33 bulk density	15.6	31.2	46.8	62.4	78.0	93.6
Future	**0.11 bulk density**	44.0	88.0	132.1	176.1	220.1	264.1
	0.33 bulk density	14.2	28.3	42.5	56.7	70.8	85.0

Average household – flats l/hh/wk		**1 week**	**2-week**	**3-week**	**4-week**	**5-week**	**6-week**	**7-week**	**8-week**
Current	**0.11 bulk density**	34.1	68.3	102.4	136.6	170.7	204.8	239.0	273.1
	0.33 bulk density	11.0	22.0	33.0	44.0	54.9	65.9	76.9	87.9
Future	**0.11 bulk density**	30.7	61.4	92.1	122.9	153.6	184.3	215.0	245.7
	0.33 bulk density	9.9	19.8	29.7	39.5	49.4	59.3	69.2	79.1

Results: container capacity – *residual*

All own-door arisings i.e. including rural&urban lower than arisings for constrained&suburban only

Example illustrated below at 0% contamination

Performance	Current		Future	
l/hh/wk	All own-door	Suburban& constrained	All own-door	Suburban& constrained
Residual	48.49	49.65	44.02	45.04
Recycling (Fully segregated)	68.03	70.17	82.00	84.50

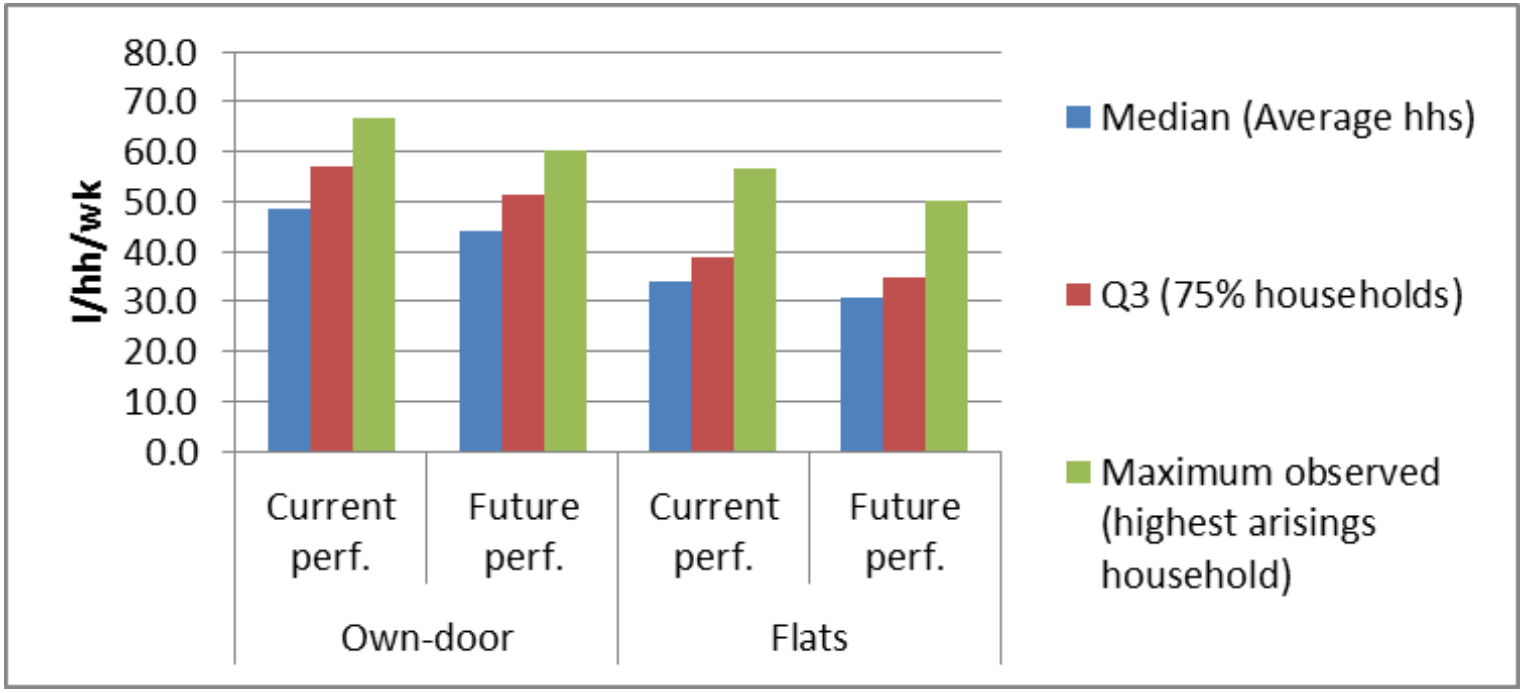
Results: container capacity - *residual*

Variation in container capacity at different levels of arising, household type and performance

		l/hh/wk		
Household type	**Performance level**	**Median (Average hh)**	**Q3 (75% hh)**	**Maximum observed (highest arisings hh)**
Own-door	Current	48.5	56.8	66.8
	Future	44.0	51.4	60.34
Flats	Current	34.1	38.9	56.5
	Future	30.7	34.6	50.3

Results: container capacity - *residual*

Variation in container capacity at different levels of arising, household type and performance



Results: container capacity – *recycling*

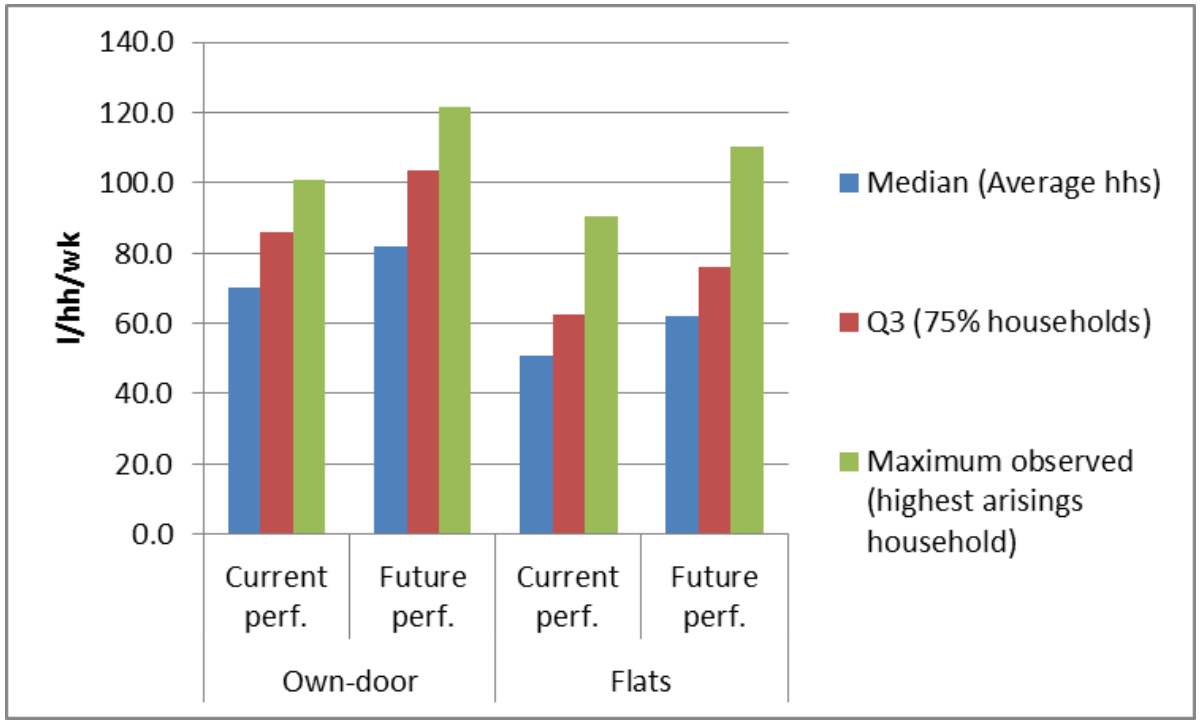
Average household – own-door l/hh/wk	Current			Future		
	0%	5%	15%	0%	5%	15%
Fully-co-mingled	57.0	59.4	65.0	62.7	65.3	71.4
Co-mingled, separate glass	69.5	71.9	77.4	78.5	81.1	87.2
Twin stream	49.5	51.9	57.4	54.5	57.1	63.2
Fully segregated	68.0	70.4	76.0	82.0	84.6	90.7

Average household – flats l/hh/wk	Current			Future		
	0%	5%	15%	0%	5%	15%
Fully-co-mingled	36.6	38.2	41.7	41.0	42.7	46.7
Co-mingled, separate glass	45.3	46.9	50.4	52.2	53.9	57.9
Twin stream	32.1	33.6	37.2	36.0	37.7	41.7
Fully segregated	49.4	50.9	54.5	60.3	62.0	66.0

Results: container capacity - *recycling*

Fully segregated – 5% recycling

Variation in container capacity at different levels of arising, household type and performance



Results: container capacity – *recycling*

Average household – own-door l/hh/wk	Current 2-week 0%	Current 2-week 5%	Current 2-week 15%	Current 3-week 0%	Current 3-week 5%	Current 3-week 15%
Fully-co-mingled	114.1	118.9	129.9	171.1	178.3	194.9
Co-mingled, separate glass	138.9	143.7	154.8	208.4	215.6	232.2
Twin stream	98.9	103.7	114.8	148.4	155.6	172.2
Fully segregated	136.1	140.8	151.9	204.1	211.3	227.9

Average household – own-door l/hh/wk	Current 4-week 0%	Current 4-week 5%	Current 4-week 15%	Current 5-week 0%	Current 5-week 5%	Current 5-week 15%
Fully-co-mingled	228.2	237.7	259.8	285.2	297.1	324.8
Co-mingled, separate glass	277.9	287.4	309.6	347.4	359.3	386.9
Twin stream	197.9	207.4	229.5	247.3	259.3	286.9
Fully segregated	272.1	281.7	303.8	340.2	352.1	379.8

Results: container capacity - *garden*

- Scenarios assume 100% capture rate for garden waste
  - Large variation depending on season, weather
  - Skews other results
- Services with garden waste in WCA studies >95% capture rate
- Table below gives range of garden yields
  - LAs with no garden service
  - LAs with no garden service in winter

	kg/hh/wk	l/hh/wk (0.2 WRAP)	l/hh/wk (0.32 EA)
min	0.01	0.05	0.03
max	4.50	22.50	14.06
mean	1.13	5.64	3.53

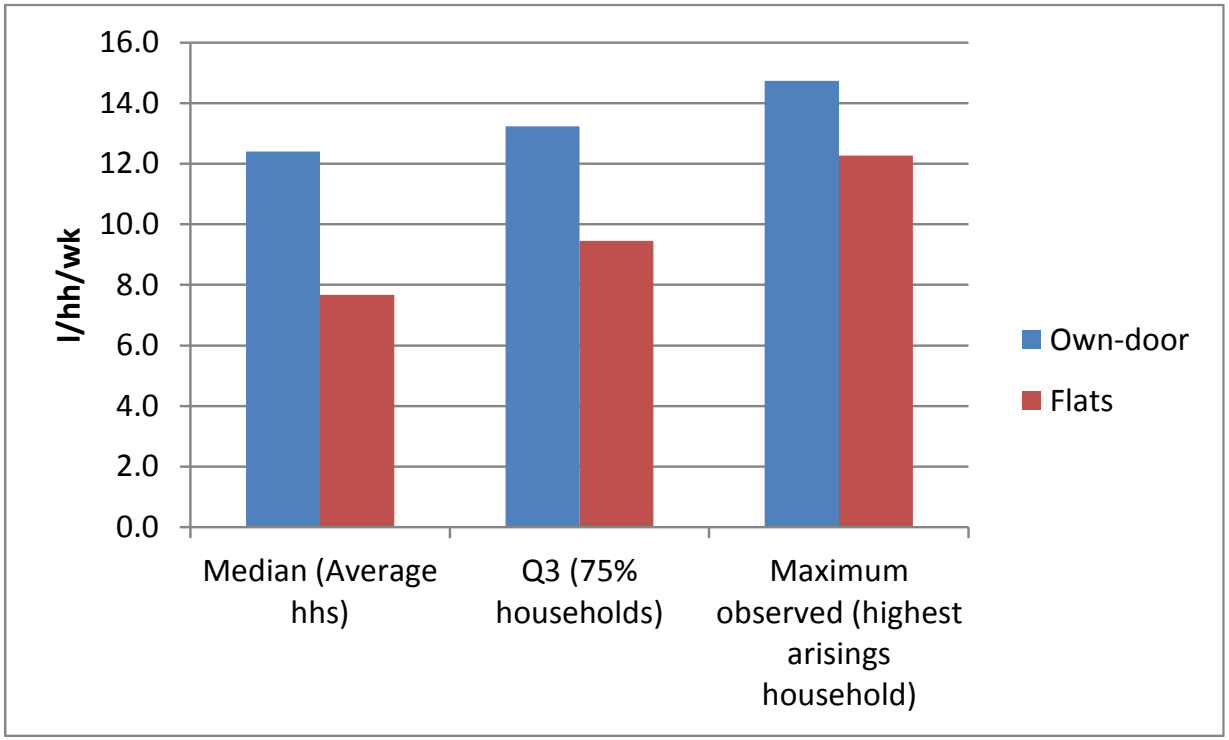
Results: container Capacity – *food*

Average household – own-door (l/hh/wk)	**Current**	**High**	**2-week current**
Food	12.4	12.4	24.8

Average household – flats (l/hh/wk)	**Current**	**High**	**2-week current**
Food	7.7	7.7	15.4

Results: container capacity – *food*

Variation in container capacity at different levels of arising and household type



Conclusions – interpretation of max observed results

- Max. obs. = highest per hhs arisings within WCA database (based on 50 hhs average)
- Only possible to apply fixed composition to generate capacities BUT
  - operationally compositions vary by hhs
  - relevant in relation to segregated service
- Estimated additional capacity required (based on max. % composition for streams from database):
  - **Up to 5 litres/wk/container all household types, other than..**
  - **Up to 10 litres/wk/container for plastics & residual in flats**

Conclusions: limitations of findings

- Biggest factors that impact results - arisings / bulk density / recognition rates
- Arisings
  - Rural & flats small amount of data – most uncertainty
  - Average (median) does not capture requirements of all households
  - Q3 (75% households) & max. obs. results illustrate additional capacity that will be required by some hhs
- Bulk density factors
  - Lack of confidence in factors – particularly around residual waste
  - Sensitivity analysis has illustrated impact on results
- Recognition rates
  - Little current data on recognition rates – most data capture rates
  - Scenarios illustrate best assessment of high performance

Conclusions: residual

- Current performance - average arisings
  - 46.8 - 145.5 litres 3-weekly collection
  - 62.4 - 194.0 litres 4-weekly collection
- Current performance - max. observed arisings
  - 64.5 – 200.3 litres 3-weekly collection
  - 86.0 - 267.1 litres 4-weekly collection
- Results suggest 140 litre container is limited to 3-weekly collections
- More data on bulk density would help to improve confidence around the results

Conclusions: dry recycling

- Current high performing hh 240 litres is sufficient capacity for average household until
  - 4-weekly collections OR
  - performance increases (recognition rates get higher)
- Contamination
  - Contamination adds to capacity required
  - Decreasing contamination mitigates need to provide more capacity as recognition improves e.g. co-mingled
    - Current15% contamination 65 litres/week
    - High 0% contamination 63 litres/week
- Variations in service delivery at future performance level
  - the ‘twin stream’ collection route requires the least capacity
  - the ‘fully segregated’ collection route requires the most capacity

Conclusions: glass and food

- Glass illustrates greatest variation
  - Extra glass capacity required above predicted arisings
  - Average is made up of heavy users and non-users
- More uncertainty around glass due to variation in service delivery i.e kerbside service vs. bring bank
- Food capacity
  - 23 litre caddy weekly collection provides sufficient capacity even when looking at maximum observed figures for arisings.

Caveats

- Flats and rural are small groups and should only be used to help understand variation
- Less certainty at higher arisings – (questionable) outliers affect est. % comp. so Q3 % comp. has been used to calculate max. observed arisings
- Bulk density factors have huge impact on capacity required
- All scenarios assume 100% recognition of garden waste
- Dense plastic packaging may include non-target materials
- Sample strata provide an average across ~ 35-50hhs
  - Variation within strata
  - AHPs (nappies etc.)
- Behaviour change w.r.t. container choice not modelled