The composition of household waste at the kerbside in 2014-15

Methodology document

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Some of the waste composition data used in national estimates was generated using household sampling frameworks developed using Experian/MOSAIC©Experian 2015 socio-demographic data.

If you would like more information on this project please call Zero Waste Scotland on 01786 433 930 and ask to speak to our research and evaluation team, alternatively use the contact form on our website:

zerowastescotland.org.uk/content/contact-form

1 Introduction

Zero Waste Scotland has published new estimates for the composition of household waste collected at the kerbside in 2014-15, from the physical analysis of waste. This document provides a detailed methodology that was used to obtain those estimates, and has been written for more technical readers. We have also produced an excel dataset of key findings, and a set of frequently asked questions. A separate summary of findings has also been written and should be referred to for the actual findings of this study.

Our summary of findings includes the following:

- How much is collected at the kerbside in total?
- What is thrown away in the residual waste bin?
- Changes in what we throw away in the residual waste bin since 2009
- How many items that could be recycled at the kerbside, are actually recycled?
- How common is it for the wrong items to end up in mixed recycling collections?

Our analysis covers the contents of the residual waste, which is the bin that should be used to dispose of wastes that cannot be recycled. We use the term residual waste, regardless of whether the contents of that bin could be recycled or not. Our analysis also covers the contents of mixed recycling containers provided to households, and we use the term "non-recyclable" waste within recycling containers to define wastes not typically recycled anywhere within a local authority service e.g non-recyclable paper and disposable nappies.

Our analysis excludes household waste collected at non-kerbside locations, such as recycling points and household waste recycling centres. It's worth remembering that significant quantities of household waste material – particularly recycled items – are also collected via these non-kerbside routes, so overall household recycling performance reported by SEPA[1] is not identified in this kerbside analysis alone. The last time a similar study was conducted was in 2009, so the findings provide an important update on kerbside waste composition.

1.1 Summary of information sources used in analysis

Our methodology consists of using information from three principle sources:

- Waste composition analysis of kerbside residual and mixed recycling streams from eighteen Scottish local authorities carried out during 2013 to 2015 (Section 2). Reference is made to the "Waste composition analysis fund programme" throughout this document.
- Waste composition analysis of kerbside mixed food and garden waste collections carried out during 2011 to 2014 (Section 3).
- Waste tonnages reported as collected at the kerbside by all thirty-two local authorities on waste data flow in 2014-15 (Section 4). Our analysis used mostly 2014 waste data flow data, but for some local authorities 2015 data was judged to be more representative of what was sampled during compositional analysis.

Secondary analysis of the three datasets is then carried out in order calculate national estimates (Section 5). A summary of the information sources used to calculate national estimates is provided in Figure 1 below.

1.2 Structure of this document

This document is structured using the following sections:

- Waste composition analysis fund programme 2013-15 (Section 2)
- Waste composition analysis of mixed food and garden waste (Section 3)
- Waste data flow datasets used in this study (Section 4)
- Methodology for national kerbside composition estimates (Section 5)
- Lessons learned from this study (Section 6)
- Appendix - Material categorisation used in final analysis

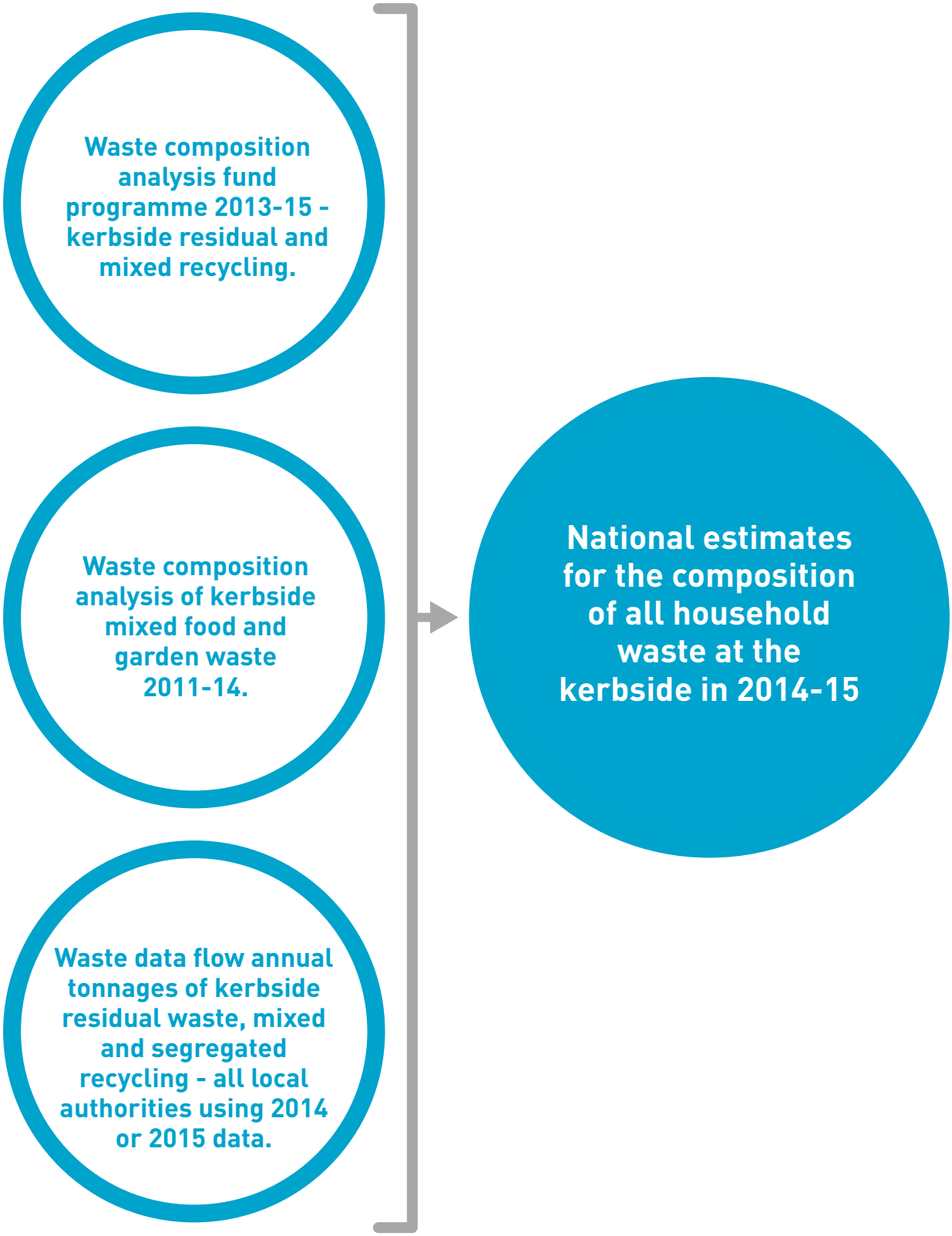
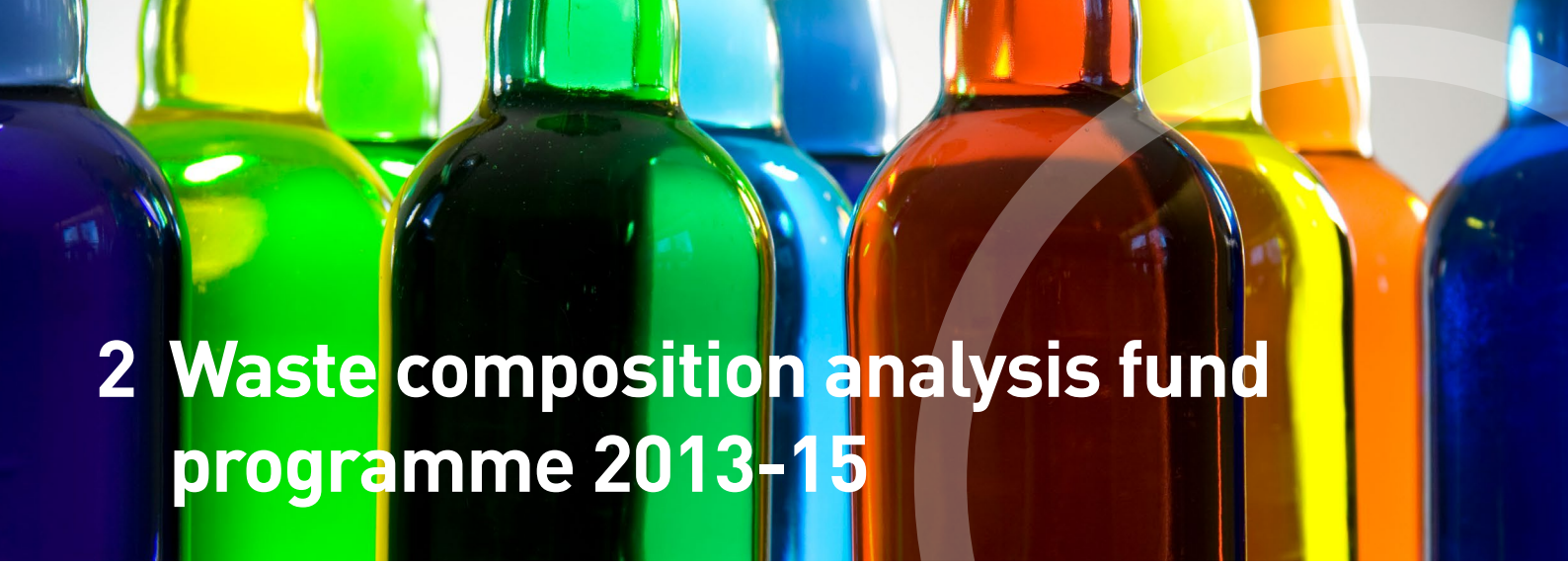


Figure 1 Summary of the information sources used to estimate the composition of household waste at the kerbside in 2014-15



2 Waste composition analysis fund programme 2013-15

During the period 2013-15 Zero Waste Scotland ran a waste composition analysis (WCA) fund programme, which was designed to support local authorities to conduct waste composition analysis.

In total eighteen local authorities utilised grant funding. In addition:

- One local authority was awarded funding but did not proceed with a project
- One local authority submitted an application but was not able to proceed with a project that aligned with the methodology guidance
- Six local authorities showed interest in submitting an application but decided not to proceed to full application; in some cases initial scoping work was carried out.

A national programme of waste composition enabled a number of key benefits when it came to utilising the data in the current study:

- Development of comprehensive guidance[2] for waste composition analysis (Section 2.1).
- Dedicated project management to oversee individual project delivery[3]
- Dedicated analytical resource enabled the creation of a comprehensive, standardised and quality assured dataset on completion of each study (Section 2.2)

2.1 Summary of methodology guidance

A key aspect of the WCA fund was the development and implementation of methodology guidance for waste composition analysis. The guidance identified a minimum set of requirements that were adopted in the funded studies:

- Composition analysis of residual and dry mixed recycling - recycling services that targeted a small number of materials (e.g paper and card) could be excluded
- Stratification to create a sampling regime that is representative of the whole local authority area
- A sampling regime that incorporates housing type or area type and a socio-economic dimension
- Each stratum should be represented by a minimum street block sample on a quota basis, with a sample size of 50 households per street block
- Two phases of fieldwork
- Standard material categories used during sorting
- Sorting of all waste collected
- Collection of the residual waste stream first in the collection cycle
- Recycling collected from the residual households only, with set-out of recycling bins recorded.

Further detailed information can be found in the guidance document. In the following sections we only highlight where there were deviations away from the guidance when deciding on the inclusion of individual datasets in final analysis.

2.2 Waste composition datasets used in final analysis

The individual WCA studies produced datasets that were immediately useful to participating local authorities (including but not limited to scaled estimates of whole authority kerbside composition). The individual studies also enabled the creation of a comprehensive, standardised dataset of kerbside composition that was suitable for use in a national-level study. Table 1 below summarises the waste composition studies that were used in our final analysis. In total, datasets from 17 local authorities participating in the WCA fund were used in final analysis.

Our final analysis also used data from one additional kerbside waste composition study provided by Fife council, which was conducted outside of the WCA fund and accompanying guidance. However, we were unable to establish the methodology used to stratify household blocks for sampling.

Further, only the second phase could be used in our final analysis, due to divergence in the material lists used during fieldwork for phase 1. However, the decision to include Fife data in final analysis was based on a lack of a suitable proxy kerbside composition (see Section 5.3).

In total, eighteen local authority kerbside waste composition studies (residual and mixed recycling) were used in final analysis. Although not shown in Table 1 above, in order to reduce the quantities of waste required for sampling, we also used compositional data from seven studies of mixed food and garden waste conducted during the period 2011 to 2014, prior to the establishment of the WCA fund[4]. Further details of these separate studies are provided in Section 3.

One additional local authority was supported by the WCA fund, but local aim of the study was narrower, and so the sampling approach conducted by the contractor did not meet

Local Authority	Number of sampling phases	Sample date	Waste streams sampled
Angus	1 2	Nov 2014 Mar 2015	Residual and co-mingled recycling
Argyll and Bute	1	Nov 2014	Residual, plus Islands recycling service, paper and card
East Ayrshire	1 2	Mar 2014 Jun 2014	Residual only
East Dunbartonshire*	1	May 2014	Residual, Glass, cans and plastic, paper and card
East Renfrewshire	1	Jun 2014	Residual only
Edinburgh	1 2	Nov 2014 Mar 2015	Residual, co-mingled recycling, packaging
Fife**	1	Jul 2015	Residual, cans and plastic, paper and card
Glasgow	1 2	Nov 2014 Mar 2015	Residual, co-mingled recycling
Highland	1 2	Jun 2014 Oct 2014	Residual, co-mingled recycling
Midlothian	1 2	Sep 2014 Feb 2015	Residual, co-mingled recycling
Moray	1	Mar 2014	Residual, co-mingled recycling, food and garden
North Ayrshire*	1	Jun 2014	Residual, co-mingled recycling, food and garden
North Lanarkshire*	1	May 2014	Residual, co-mingled recycling
Perth and Kinross	1 2	Nov 2013 Mar 2014	Residual, co-mingled recycling
Renfrewshire*	1	Jun 2014	Residual, co-mingled recycling
South Ayrshire	1 2	Nov 2014 Mar 2015	Residual, co-mingled recycling
South Lanarkshire	1 2	Nov 2013 May 2014	Residual, co-mingled recycling
West Lothian	1 2	Feb 2014 Jun 2014	Residual, co-mingled recycling

Table 1 Summary of local authority waste composition studies used in final analysis. All studies except Fife were conducted under the WCA fund programme

*Two phases of sampling was conducted for these authorities. However, for the first phase of sampling, the licensing conditions placed on the authorities by the provider of socio-demographic data meant that we were unable to use the data in a national study.
**Waste composition data derived from the local authorities own study conducted outside of the WCA fund programme. Two phases were conducted, but only the second phase could be used in our final analysis (due to divergence in the material lists used).

the criteria in the WCA guidance (sampling was conducted on flatted properties only). Data from this study has not been used in final analysis. Zero Waste Scotland also identified a further three local authority waste composition studies of residual waste conducted prior to the establishment of the WCA fund. However, we were unable to establish if the licensing conditions placed on the authority by the provider of socio-demographic data enabled us to use the data in analysis and reporting, so we did not include them in our final analysis.

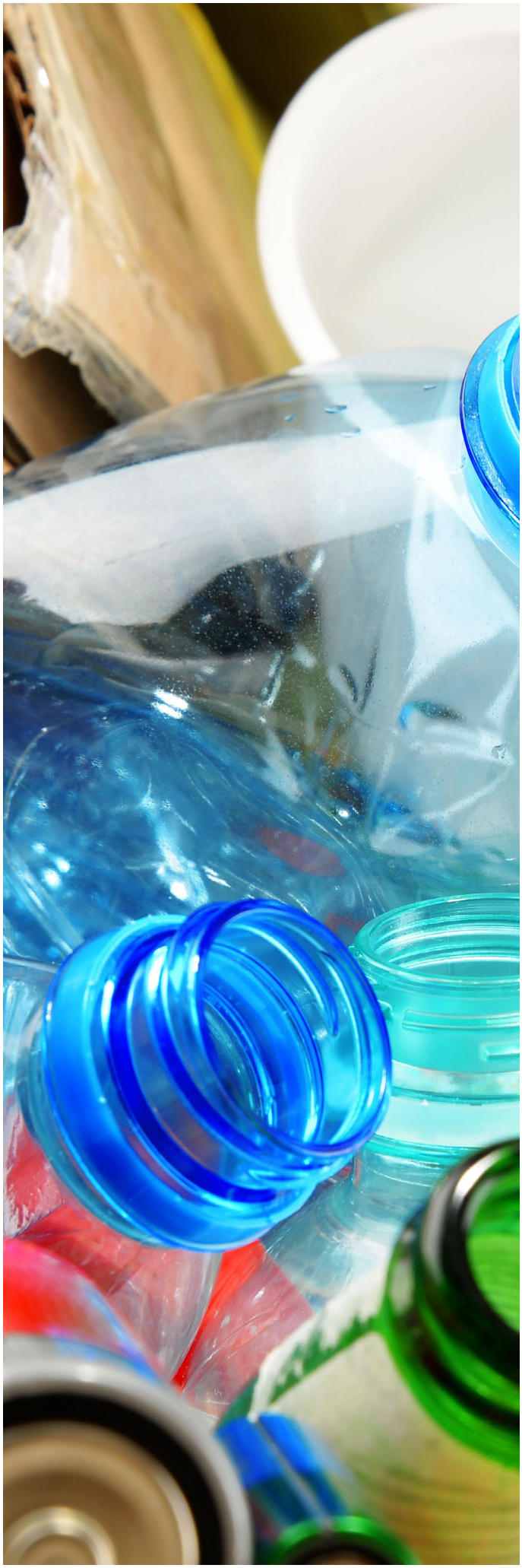
In the following sections we provide a coverage assessment for the eighteen kerbside composition studies used in final analysis, broken down by a number of variables.

2.2.1 Coverage by the number of sampling phases conducted

The WCA guidance recommended conducting a minimum of two phases of sampling in spring/early summer and autumn/early winter. In practice, this recommendation was met by ten of the local authority studies included in final analysis. The phase 1 data for North Ayrshire, North Lanarkshire, Renfrewshire and East Dunbartonshire was not included in final analysis, due to the licensing conditions placed on the authorities by the provider of socio-demographic data used to derive the household sample in phase 1. In these cases an alternative socio-demographic data source was used for phase two, further details on this issue are provided in Section 6.2.

2.2.2 Coverage by sampling date

In terms of sampling date, the majority of sampling was conducted during 2014, with a smaller number in 2013 and 2015. Waste composition sampling was not set up to identify any seasonal effects per se, but there was a good mix of studies conducted across the late spring and autumn periods[5]. Waste composition studies are by their nature a snapshot in time, and were conducted at a time of significant change to waste collection services in Scotland. Local authorities were keen to conduct compositional analysis where they had recently implemented a service change. This was an important consideration when deciding on the waste data flow reporting years used in final analysis (further details are provided in Section 4.1).



2.2.3 Coverage by waste streams sampled

All eighteen local authorities were sampled for their residual waste. In two cases only residual waste was sampled, where recycling services targeted a small number of "mixed" materials, such as paper and card and mixed glass. Sampling of mixed recycling streams focused heavily on co-mingled collections, with a smaller number of studies of dual stream dry recycling and mixed food and garden waste.

2.2.4 Coverage by local authority national share of multiple deprivation

The individual local authority waste composition studies conducted via the WCA fund were designed to be as representative as possible of households in a local authority area. Further details of the stratification requirements are set out in the accompanying guidance document[6].

In terms of the degree to which individual local authority waste composition studies used in final analysis are broadly representative of Scotland as a whole, one useful measure is the local authority's national share of the most deprived areas of Scotland. If the local authorities for which we had waste composition data made up only a small proportion of the most deprived data zones in Scotland, we might be concerned about how representative they are of Scotland as a whole[7].

The Scottish Index of multiple deprivation[8] provides a rank for all the 6,976 data zones in Scotland, where a rank of 1 is the most deprived and a rank of 6,976 is the least deprived. The ranks cannot be averaged to obtain a deprivation score for local authority areas. However, the concept of national share of the most deprived data zones is useful for the current study in order to describe levels of deprivation in sampled and non-sampled local authorities[9]. To find a local authority's national share, we firstly identified the most deprived data zones in Scotland by applying a cut-off (15% most deprived is typically used), we then calculated the proportion of the data zones identified as 'most deprived' that belong to that area. For example: There are 1046 data zones that fall in the 15% most deprived in Scotland, of which Dundee has 55 data zones, so Dundee's national share is 55/1046, or 5%.

The coverage, by levels of deprivation of participating and non-participating local authorities is provided in Figure 2 below. Local authorities that were used in our final analysis represented just over 80% of the national share of the 15% most deprived SIMD data zones, suggesting that the local authorities with composition data are broadly representative of Scotland in terms of levels of multiple deprivation.

2.2.5 Coverage by quantity of kerbside residual waste

A useful measure of the degree to which local authority waste composition data was broadly representative of a national picture is the overall quantities of residual waste used in our final analysis. Further to Table 2, on the next page, approximately 68% of the total kerbside residual waste used in final analysis was from local authorities where we had residual waste composition data. As per Section 4.1, waste data flow tonnages used in final analysis were a mixture of 2014 and 2015, so the total kerbside residual tonnage will not exactly match that reported on waste data flow for either 2014 or 2015.

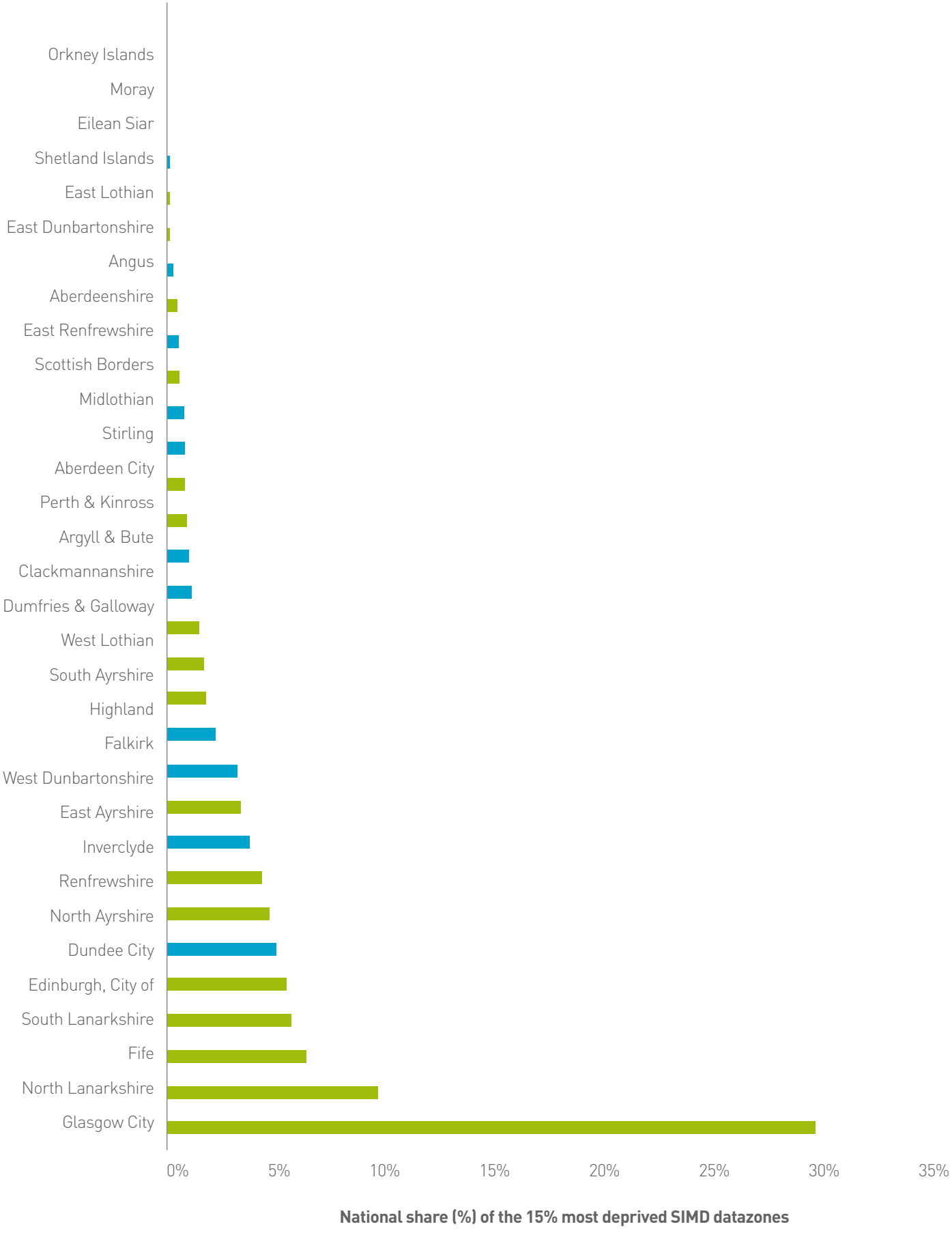


Figure 2 Local authority national share of the 15% most deprived data zones for SIMD 2016. Amber shading denotes those local authorities where waste composition data was used in final analysis

	Total tonnes of residual waste arising	% of all residual waste used in final analysis
Local authorities where residual waste composition was conducted (sampled authorities)	768,369	68%
Local authorities where residual waste composition not conducted (non-sampled authorities)	365,313	32%
Total kerbside residual waste used in final analysis	1,133,682	

Table 2 Total kerbside residual waste used in final analysis, split by whether we had residual waste composition data for the local authority

3 Waste composition analysis studies of mixed food and garden waste

During the WCA fund, one of the tasks was to identify if there were any recently completed composition analysis studies that could be used alongside those conducted via the fund. Utilisation of previous studies for mixed food and garden waste enabled prioritisation of budgets during compositional fieldwork towards the compositional analysis of residual waste and dry recycling.

Prior to the establishment of the WCA fund, during the period 2011-12, Zero Waste Scotland supported five local authorities to conduct compositional analysis of mixed food and garden waste. Following a review of the methodologies employed (in terms of the guidance summarised in Section 2.1 and the material categories used during analysis), these studies were all deemed suitable for use in a future national study. To supplement these studies, a further two local authorities conducted composition analysis of their mixed food and garden waste services during 2014, as part of the waste composition fund programme.

Table 2 below summarises the mixed food and garden studies used in final analysis. In total, there were seven local authority studies available to use as standard compositions when transposing the "mixed garden and food waste", "Green garden waste only" and "waste food only" reporting categories from waste data flow, into our final analysis (see Section 4.3). All of the studies above were conducted using a single phase of spring sampling, and five of the seven studies use a fortnightly collection. Both of these factors could have potentially impacted on the observed quantities of food and garden waste. For example, food waste yields in mixed food and garden waste collections have previously been found to be significantly different for weekly and fortnightly collections[10].

As a sense check, we reviewed the average % composition estimates for food wastes contained within weekly and fortnightly collections calculated from the seven studies above, against those used to estimate household food and drink in Scotland for 2014[11]. We found good agreement with weekly collections (26% vs 27%), but a larger difference with fortnightly collections (21% from the seven studies above, vs 14% from UK studies). Since five of the seven studies above were fortnightly (and ultimately this data would be applied to their own reported tonnages on waste data flow), we concluded it was better to apply our calculated average, rather than those derived from other UK studies.

Future studies may wish to seek out more recent estimates of the split in waste in mixed food and garden collections if mixed collections grow in popularity, especially if an understanding of food waste arisings is a primary aim. Food waste proportions in areas with mixed collections may be influenced by contextual factors (such as a history of having separate collections in some cases), or by changes in food waste collection behaviours over time. Additionally, as green waste is by far the most seasonal waste stream, this may complicate our ability to calculate and then apply straightforward percentage splits by waste type.

Local Authority	Collection frequency – Food and Garden	Sample date
Aberdeen	Fortnightly	Feb-March 2011
East Renfrewshire	Weekly	Feb-March 2012
North Lanarkshire	Fortnightly	Feb-March 2013
Perth and Kinross	Fortnightly	March 2012
West Dunbartonshire	Fortnightly	April 2012
Moray*	Fortnightly	March 2014
North Ayrshire*	Weekly	May-June 2014

Table 3 Summary of mixed food and garden waste composition studies used in final analysis, unless indicated all studies conducted prior to establishing the WCA fund

4 Waste data flow datasets used in this study

The waste data flow (WDF) system is used by Scottish local authorities to report the collection and management of household wastes. For the current study, we used the quantities of waste reported as collected by local authorities at the kerbside in questions 10 (kerbside recycling) and 23 (kerbside residual waste).

4.1 Reporting years used in final analysis

The WCA fund took place at a time of significant change in local authority kerbside waste services. In some cases, participating local authorities wished to sample from households covered by a new service, prior to wider roll out. We accessed both 2014 and 2015 calendar year WDF data as part of our analysis. This enabled sense checking of reported tonnages against what we knew about changes in service during the two periods, and as accurate as possible matching of waste composition data to WDF reported tonnages.

In final analysis we used 2014 WDF data for twenty six local authorities, and 2015 for six local authorities. Results are therefore representative of a 2014-15 period and will not exactly match reported tonnages for either 2014 or 2015.

We used 2015 data where it was more reflective of the household services we sampled from during waste composition, even if the waste composition may have been conducted in 2014. The six local authorities where we used 2015 data were Aberdeenshire, Angus, East Ayrshire, Edinburgh, Glasgow and South Ayrshire. On balance we concluded that the benefits of using data spanning two reporting years (in terms of more accurately reflecting the composition data we held) outweighed any small disadvantages (in terms of using a mix of 2014 and 2015 WDF data as the basis for analysis).

4.2 Review of local authority data prior to use in final analysis

Given this methodology's very heavy reliance on the quantities of waste reported by local authorities on WDF, prior to inclusion in final analysis we reviewed tonnages reported in 2014 and 2015 by all local authorities on WDF.

We sense checked the household kerbside residual waste tonnages reported on question 23 using yield estimates (kg/capita/year) and commercial and household splits for all thirty-two local authorities. There was relatively little variation between local authorities, or where there was divergence from averages the underlying cause was well understood (e.g "Island" local authorities tend to have a higher proportion of commercial waste due to a lack of private sector waste management companies).

In one exceptional case we identified a very low household kerbside residual yield (0.12 tonnes per capita in 2014), and kerbside household residual waste made up only 57% of the total household and commercial residual waste collected. After consulting with Zero Waste Scotland experts with extensive knowledge of local authority collections, the underlying reasons for this divergence from typical patterns was not established. In this case we therefore used the household residual waste yield from a neighbouring authority as a proxy (0.19 tonnes per capita per year, which translated to a revised estimate of 14,965t per annum). The proxy authority was the third most similar authority using nearest neighbour analysis (for further details see Section 5.3.1), with a very similar kerbside recycling service in place.

For kerbside recycling tonnages reported in WDF Question 10, we sense checked yield estimates (tonnes per capita) and household and commercial splits. In one local authority there was no commercial glass reported in WDF Question 100 despite offering a commercial service, and the household glass tonnage reported in WDF Question 10 (on a per capita yield basis) was also very high. In one additional local authority no kerbside household glass was reported in WDF Question 10; however, it is understood that households receive a service. In both these cases we did not make any adjustment to reported data.

Section 6 of this document summarises our learning from the use of local authority data from WDF for a national waste composition study such as this.

4.3 Estimating the composition of all recycling reported on waste data flow

The calculation of national kerbside composition estimates relies on summing all of the recycling components reported on question 10 of waste data flow (WDF). To do this, there is a requirement to transpose the WDF reporting categories into the waste composition categories used in our analysis (see Appendix for a detailed list of waste composition categories).

For some WDF reporting categories the summing process is straightforward. For example, the tonnage of "steel cans"

directly transposes to the category "Cans – Steel" in our waste composition categories.

For the WDF reporting categories listed in Table 4 below, the transposition is more complex and relies on the use of either:

- The local authorities own waste composition data (e.g physical analysis of a co-mingled recycling collection in order to define the composition). In this case we applied their own composition profile for co-mingled recycling to the reported tonnages of "Co-mingled materials" on waste data flow. or,
- Where we lacked local authority-specific composition analysis of a recycling stream, we identified a set of standard composition profiles that we could apply to reported tonnages, in order to transpose to our waste composition categories. For example, if a local authority reported "mixed garden and food waste" on waste data flow, but we did not have waste composition data for their service, we applied the average overall composition from seven waste composition studies of mixed food and garden waste.

Table 4 below details the WDF recycling categories that required transposition and provides a summary of the standard composition data sources used in final analysis. One of the benefits of a national study comprising of thirty-two local authorities was that we could quality assure our proposed application of any standard compositions to WDF tonnages. Where there was some ambiguity regarding what was reported on WDF, we sought information from experts in ZWS and/or from the local authority. This process enabled us to more accurately match up WDF reporting categories with the compositional profiles we had available.

The "co-mingled materials" reporting category on WDF tended to be the source of most uncertainty. For example, for a single local authority that reported "co-mingled materials" in Q10, we established that tonnages reported represented a mixed cans and glass service. In this case we used a 90:10 split provided by the local authority to apportion mixed glass and mixed cans respectively. We then applied separate, standard composition profiles for "mixed glass" and "mixed cans" in order to match to our detailed waste composition categories. For another local authority, we established that "co-mingled materials" represented a mixed cans service. In this case we applied a standard composition for mixed cans in order to match to our detailed waste composition categories.

For seven local authorities who reported 'textiles only' and 'textiles & footwear' in Q10, we applied one third 'clothing textiles', one third 'Shoes, belts & bags' and one third 'Non-clothing textiles'.

Waste data flow category	Source of standard composition data (where we lacked specific data for that authority)
Co-mingled materials	Average composition taken from "standard" DMR (10 studies), DMR with glass (3 studies), DMR with glass & film (1 study) and DMR multi-occupancy (1 study).
Green garden waste only	Average composition of the garden waste component of seven waste composition studies of mixed food and garden waste (see Section 3).
Mixed garden and food waste	Average overall composition from seven waste composition studies of mixed food and garden waste.
Waste food only	Average composition of the food waste component of seven waste composition studies of mixed food and garden waste.
Mixed paper & card	Average composition taken from one single stream and one dual stream study.
Mixed glass	Average composition taken from the glass components of four DMR and two dual stream studies.
Paper	Average composition taken from the paper components of twelve DMR, three dual stream and one single stream studies.
Other compostable waste	A single local authority reported under this category, which we treated as Green garden waste only.
Plastics	Average composition taken from the plastics components of six DMR and one dual stream studies.
Mixed Plastic Bottles	Average composition taken from plastic bottles components of two DMR and two dual stream studies.
Mixed cans	Average composition taken from mixed cans components of thirteen DMR, three dual stream and one single stream studies.
Textiles & footwear	Lack of any compositional data, sum of 'textiles only' and 'textiles & footwear' estimated as 33:33:33 'clothing textiles', 'Shoes, belts & bags' and 'Non-clothing textiles'.
Textiles only	As above.

Table 4 Waste data flow (WDF) reporting categories that required transposition to the waste categories used in the current study, including sources of standard composition data

5 Methodology for national kerbside composition estimates

5.1 Introduction

The following sections describe the methodologies employed to calculate national kerbside composition estimates from individual local authority data, using waste composition analysis and waste data flow data.

The methodologies can be broadly split according to whether a given local authority had participated in kerbside waste composition analysis during the 2013-15 period (see Section 2.2), and therefore we had a waste composition profile available that was specific to that authority.

Where we had local authority compositional analysis for a given waste stream, we used that data when calculating overall kerbside composition for the local authority.

Where we did not have a composition profile for a given local authority and waste stream, we identified and applied a proxy local authority composition, using a combination of kerbside waste service characteristics and local authority "nearest neighbour" analysis.

5.2 Local authorities with waste composition data

5.2.1 The composition of kerbside residual waste

To estimate the composition of kerbside residual waste for each local authority that participated in the waste composition analysis, the raw % values (from raw kg observations) from each sampling phase and household group (strata) were weighted according to the number of households represented by each strata. Where two phases of sampling was conducted, the weighted values for each phase were then combined to give an estimated annual composition of residual waste (%). We then multiplied by the annual kerbside residual waste (tonnes) reported on waste data flow, to estimate the annual residual waste composition (tonnes).

5.2.2 The composition of all kerbside recycling

To estimate the composition of all kerbside recycling for each local authority that participated in the waste composition analysis fund, we summed:

- The quantity (tonnes) of each material reported as separately collected recycling on waste data flow (i.e that not requiring transposition to our waste composition categories, see Section 4.3).
- The quantity (tonnes) of each material estimated to be in mixed recycling collections sampled during compositional analysis, using the authorities own compositional analysis data (weighted as per residual waste above), which was then applied to the corresponding waste data flow tonnages.
- The quantity (tonnes) of each material estimated to be in mixed recycling collections not sampled during waste composition analysis, using standard compositions (see Section 4.3) from other studies, which was applied to the corresponding waste data flow tonnages.

5.2.3 The overall tonnage and composition of kerbside waste

To estimate an overall kerbside composition for each local authority with composition analysis, the kerbside recycling and residual tonnage estimates were then combined to give an overall kerbside tonnage and % composition.

5.3 Local authorities without waste composition data

The methodology for estimating the overall kerbside composition (residual plus recycling) for local authorities where we lacked waste composition data consisted of the following steps:

- We identified a suitable proxy local authority who had participated in kerbside waste composition analysis
- We applied the proxy overall kerbside composition profile to the local authorities own data from waste data flow, in order to estimate the overall composition of kerbside waste
- We calculated the composition of all recycling collected at the kerbside as reported on waste data flow
- We estimated the composition of kerbside residual waste, using the overall kerbside composition estimate and the composition of all recycling

Further details of each analysis step are provided in the following sections.

5.3.1 Allocating a proxy kerbside composition

The process for selecting a suitable proxy local authority kerbside composition consisted of using a combination of information on kerbside waste service characteristics[12] and local authority "nearest neighbour" analysis. A summary of nearest neighbour analysis is provided immediately below. Nearest neighbour analysis consisted of using data sourced from the office for national statistics for each local authority in Scotland, based on a wide range of socio-demographic data from the 2011 census[13]. The degree of similarity between two local authorities can be expressed as the squared euclidean distance (SED).

The SED is a dissimilarity measure; the larger the SED value between two local authorities, the more dissimilar they are.

For example, we did not have waste composition data for East Lothian, but Midlothian had a SED value of 2.92, which ONS define as "very similar", so provided waste service characteristics were a good match, we applied Midlothian data. In other cases (e.g Falkirk), we eventually used the 4th closest SED value (which was still 2.42, or "very similar"), alongside whether any of the potential proxy authorities collected garden and glass waste at the kerbside. In this case, we defined East Ayrshire as the most suitable proxy overall.

Table 4 below summarises how information from both sources was applied in practice. By using both waste service and socio-demographic characteristics in combination, it was hoped that overall this would provide a more accurate proxy kerbside composition, where composition analysis data was lacking.

In practice, the main issue we identified with this approach was an over-reliance on a single local authority's composition data where they did not collect garden waste at the kerbside (further details are provided in Section 6.3).

Local authority requiring a proxy kerbside composition	Local authority kerbside waste composition applied in final analysis	Comments on individual decisions for final analysis
Aberdeen City	Edinburgh, City of	Only "somewhat similar", but both target glass and garden waste.
Aberdeenshire	Argyll & Bute	Not within closest five nearest neighbour. Only local authority with residual waste composition and no kerbside garden waste collection.
Clackmannanshire	East Ayrshire	"Very similar" nearest neighbour, both collect glass and garden waste at the kerbside.
Dumfries & Galloway	Argyll & Bute	Dumfries & Galloway is 5th nearest neighbour of Argyll & Bute. Only local authority with residual waste composition data and no garden waste collection.
Dundee City	Edinburgh, City of	Glasgow is nearest neighbour, however garden and food waste services more representative of Edinburgh.
East Lothian	Midlothian	Very similar" nearest neighbour, both collect garden waste.
Eilean Siar	Angus	"Similar" nearest neighbour with residual waste composition data. Waste services a fair match.
Falkirk	East Ayrshire	"Very similar" nearest neighbour, with garden waste and glass service.
Inverclyde	North Lanarkshire	No LA within 5th nearest neighbour with garden waste and no glass service. Selection based on service match.
Orkney Islands	Argyll & Bute	No LA within 5th nearest neighbour. Only local authority with residual waste composition data and no garden waste collection.
Scottish Borders	Argyll & Bute	Scottish Borders is 3rd nearest neighbour of Argyll & Bute ("similar"). Only local authority with residual waste composition data and no garden waste collection.
Shetland Islands	Argyll & Bute	No LA within 5th nearest neighbour. Only local authority with residual waste composition data and no garden waste collection.
Stirling	Moray	No LA within 5th nearest neighbour with kerbside glass. Angus better fit; however, Moray has dual stream and mixed food and garden.
West Dunbartonshire	North Lanarkshire	Highest nearest neighbour (3rd) with garden waste and no glass

Table 5 Summary of local authorities without waste composition analysis, including the proxy local authority compositions used to estimate overall kerbside composition. Comments are provided to highlight the individual judgements made.

5.3.2 The overall composition of kerbside waste

To estimate the overall composition of kerbside waste for each local authority where we lacked waste composition data, we multiplied the overall kerbside composition from their proxy local authority (%, as above) by the total kerbside tonnage reported by the local authority on Questions 10 and 23 of waste data flow.

Worked example
Sum of (Question 10 recycling excluding bulky waste[14]) and (Question 23 residual waste) = 17,557t in 2014
Multiplied by....
The estimated overall kerbside composition of green container glass (2.4%), from proxy composition
= 421t of green container glass in kerbside waste in total

5.3.3 The composition of all kerbside recycling

To estimate the composition of all kerbside recycling for each local authority where we lacked waste composition data, we summed:

- The quantity (tonnes) of each material reported as separately collected on waste data flow (i.e those not requiring transposition to our waste composition categories)
- The quantity (tonnes) of each material estimated to be in mixed recycling collections, using standard compositions (see Section 4.3) from other studies, which were applied to waste data flow annual tonnages.

Worked example
360t of separately collected green glass from Question 10 on waste data flow plus,
18t of green glass in comingled recycling (estimated by applying the composition profile from a suitable proxy co-mingled composition, using a total of 4,205t of comingled recycling reported on waste data flow)
= 378t of green container glass in all kerbside recycling services

5.3.4 The composition of kerbside residual waste

To estimate the composition of kerbside residual waste for each local authority where we lacked waste composition data, we subtracted their estimated overall kerbside recycling tonnage (Section 5.3.3 above) from our estimated overall kerbside tonnage.

Worked example
(green container glass continued from above)
Of the 421t of green container glass estimated to be in the overall kerbside waste, we subtract 378t of green container glass collected at the kerbside for recycling
= 43t of green container glass in kerbside residual waste

As with all estimation methods, the method described above will introduce error. This is most clearly highlighted in the calculations described above where negative values are sometimes produced for individual materials within the residual waste.

For example, one of the largest single negative values was where we estimated that Stirling collected 789 tonnes of "woody and bulky garden waste" at the kerbside in total using their proxy kerbside composition data. We also estimated that their kerbside garden waste contained 1,684 tonnes of "woody and bulky garden waste" within their kerbside garden waste collection. Using the calculation above, we estimated there was minus 895 tonnes of "woody and bulky garden waste" within their residual waste.

To provide a sense of scale, of the 365,313 tonnes of residual waste reported on waste date flow by local authorities that did not participate in the waste composition analysis fund (i.e the quantity we were estimating composition for), the sum of calculated negative values using the methods described above was 3,925 tonnes. Since both positive and negative values will occur (i.e under- and over-estimates), we did not attempt to adjust the estimated values in any way.

5.4 What we throw away at the kerbside that could be recycled

To estimate the portion of the kerbside residual waste comprising materials that are typically collected at the kerbside for recycling, we applied the "Typically recycled at the kerbside" material categorisation detailed in appendix to the estimated kerbside residual composition for all thirty-two local authorities.

Our analysis is a gross national estimate to highlight the scale of what we currently throw away in the residual waste that could be collected at the kerbside for recycling using typical kerbside services. Our analysis focuses on materials typically collected at the kerbside for recycling.

We do not account for any variation in the coverage of kerbside services for individual local authorities. Therefore we exclude textiles and similar that are typically collected at bring banks and household waste recycling centres notwithstanding the fact some individual local authorities might target those wastes.

Conversely, there may be cases where an authority, or some households in an authority would not have a kerbside collection for materials on our "typical" list. For example, a local authority may not collect glass at the kerbside, or only a percentage of households in a local authority area might be provided with a particular recycling service.

It was beyond the scope of the current study to individually assess additional kerbside recycling potential on an individual local authority basis for each of Scotland's thirty-two local authorities, though clearly the data produced by compositional fieldwork can be used for this purpose at local level where appropriate.

5.5 The biodegradable content of residual waste at the kerbside

To estimate the biodegradable content of kerbside residual household waste, a set of biodegradability assumptions was applied to the materials list used in waste composition analysis. A full list of the assumptions can be found in the appendix.

The biodegradability assumptions we used were cross checked with those used in similar previous studies[15]. Where possible[16] we also sense checked our assumptions with those used by SEPA to estimate the biodegradable content of waste to landfill each year. For example, SEPA currently assume a 63% BMW content for household wastes and similar (EWC code 20 03 01), which is similar but not the same as our

overall estimate for household residual waste at the kerbside (60%).

We emphasise again that our estimates relate only to residual waste collected at the kerbside, and not to all household wastes manged by local authorities.

5.6 Correct recycling at the kerbside

We define correct recycling as the proportion of the overall kerbside tonnage that we estimate is found in the correct kerbside recycling service. The calculation combines data on the composition of kerbside residual waste, with mixed and segregated recycling, in order to estimate the proportion of correct recycling at the kerbside.

Correct recycling at the kerbside – example calculation for Glass
(2,845 tonnes collected at the kerbside in total minus 679 tonnes in the residual waste minus 8 tonnes (sum of all contamination in other recycling streams not targeting glass)) divide by
2,845 tonnes collected at the kerbside in total
= 76% correct glass recycling at the kerbside

Our analysis focuses on the eighteen local authorities that took part in waste composition analysis.

Contamination in the calculation above is defined as materials that are not targeted within a given recycling service. For example green glass in a co-mingled collection that does not accept glass. Details of target and non-target materials were provided by each local authority at the time of waste composition analysis.

In final reporting we provide average, maximum and minimum % correct recycling for eight waste types typically recycled at the kerbside.

In final reporting we exclude any data points where a local authority did not target a given waste type for recycling at the kerbside[17]. Our analysis is therefore correct recycling when targeted at the kerbside, as we think this is analytically more useful when calculating averages and minimum values.

Our analysis is a whole local authority assessment of what was collected for recycling at the kerbside (in both target and non-target recycling collections), as a proportion of what we estimate is found at the kerbside in total (from compositional analysis of what is thrown away in the residual waste). We do not make any adjustment for kerbside recycling service coverage, where a recycling service was provided to only a percentage of the households in a local authority area – i.e. we assume the households we sampled (and the service they receive) are representative of the whole local authority. The method described here (where we make allowance for whether a given local authority targets a waste type at the kerbside) is contrasted with that described in Section 5.4 (materials typically recycled at the kerbside within the residual waste). In the latter case we do not adjust for individual local authorities that did not target a given waste type at the kerbside.

5.7 Contamination in mixed recycling collections

As part of the work described in Section 2, waste composition analysis was conducted on thirteen local authority dry mixed recycling services ("co-mingled recycling"), and a further five mixed recycling collections where less co-mingling took place[18].

The correct destination for each waste type used in composition analysis was defined for each local authority, with input from the local authority at the time of waste composition analysis.

Our analysis used correct destination information to classify waste types into one of three groups:

- **Target** - wastes targeted for collection at kerbside by the local authority e.g recyclable paper and card
- **Non-target** – wastes not targeted at kerbside, but were targeted elsewhere by the local authority service e.g recyclable glass might be targeted using a separate kerbside glass collection, or via bring banks
- **Non-recyclable** – wastes not typically recycled anywhere within a local authority service e.g non-recyclable paper and disposable nappies

We use the term "non-recyclable" waste within mixed recycling collections to define wastes not typically recycled anywhere within a local authority service e.g non-recyclable paper and disposable nappies.

Four of the thirteen co-mingled collections that were analysed targeted glass at the time of waste composition analysis.

In the summary report the average, maximum and minimum values are provided for target, non-target and non-recyclable wastes.

5.8 Household estimates used in final analysis

Local authority household estimates used in final analysis were taken from the national records of Scotland[19]. A mixture of 2014 and 2015 household estimates were used in order to match up with the corresponding local authority waste data flow datasets used in final analysis. National household estimates for 2014 and 2015, and the basis of our analysis are provided below.

- National household estimates for Scotland 2014 = 2,418,336
- National household estimates for Scotland 2015 = 2,433,955
- Basis of our analysis (combination of 2014 and 2015) = 2,423,839

5.9 Population numbers used in final analysis

Local authority population estimates used in final analysis were taken from the national records of Scotland[20]. A mixture of 2014 and 2015 population estimates were used in order to match up with the corresponding local authority waste data flow datasets used in final analysis. National population estimates for 2014 and 2015 and the basis of our analysis are provided below.

- Population estimates for Scotland 2014 = 5,347,600
- Population estimates for Scotland 2015 = 5,373,000
- Basis of our analysis (combination of 2014 and 2015) = 5,361,890

6 Lessons learned from this study

Upon completion of the waste composition analysis fund, Zero Waste Scotland produced a lessons learned document that reflected on our experience of supporting and co-ordinating a lengthy and complex project. This section does not duplicate that work but identifies additional learning points from the methodologies used to derive national estimates described in this document.

6.1 The value of a dedicated funding programme

The dedicated programme of waste composition funding and associated support delivered a number of key benefits that were important to the subsequent delivery of a national study of kerbside waste composition:

- Development of comprehensive guidance for waste composition analysis
- Dedicated project management to oversee individual project delivery
- Standardisation of methodology (e.g how materials are recorded)
- Dedicated analytical resource enabled the creation of a comprehensive, standardised and quality assured dataset on completion of each study
- Standardised outputs allowed their use in the work described here, and in the development of government priorities e.g food waste prevention target and the technical support that Zero Waste Scotland provides to local authorities.

The funding programme resulted in the most extensive and most consistent dataset on kerbside composition in Scotland to date. We believe it compares favourably to approaches in other European countries. As well as this report, and the data provided to individual local authorities, the information collected has already informed estimates of Scottish and UK household food waste arisings, and is likely to inform future studies focused on specific material flows.

6.2 Methodology for defining a household sample in each local authority area

During the life of the waste composition fund, one of the challenges we encountered was the ability to use waste composition data generated using one of the commercial socio-demographic packages (in order to draw up a representative sample of households). In four local authority cases, the licensing conditions placed on the authorities by the data provider meant that we were unable to use the data derived from one of the two phases of sampling in the current national study. Careful consideration of data reuse options in any future studies should maximise their value.

In some of the studies conducted later in the programme, publicly available data based on the census was used to derive a household sample. Zero Waste Scotland is currently finalising a guidance document based on this method, which we hope to have available soon. This will increase the sampling options available at local authority level in future, and potentially reduce the cost burden of future fieldwork.

6.3 Methodology for estimating waste composition where data was lacking

Any national-scale waste composition study will rely on using the findings from waste composition analysis from sample local authorities, and applying those findings to local authorities where we do not have waste composition data.

Local authorities that took part in the waste composition analysis fund were grouped into the following categories:

- Urban weekly residual;
- Urban fortnightly residual;
- Mixed fortnightly residual; and
- Rural

It was originally envisaged that average kerbside compositions from these groupings would then be applied as proxy compositions to local authorities without waste composition data, by allocating each authority without composition data to one of the four groups.

Analysis of composition data suggested there was as much variation within the groups above as between the groups. In particular, the 'mixed fortnightly residual' and 'rural' groups produced very similar composition profiles to each other.

The overall quantity of waste at the kerbside per capita was also calculated for the sampled authorities. It was found that:

- The overall quantities of food waste (residual and separately collected) tended to be lower where a kerbside service is provided. The causes of this are not clear.
- The overall quantities of garden waste tended to be higher where a kerbside service is provided. However, where no separate kerbside service is provided a higher percentage

is generally observed in the residual waste. We assume that some households are more likely to home compost or allow material to decompose naturally where no collection is available.
- The quantities of glass tended to be higher where a kerbside service is provided. As this study does not consider non-kerbside routes, these may account for the difference in these cases.

Regardless of what the findings tell us about service characteristics, analytically, this led us to conclude that overall kerbside service characteristics are at least equally important as the original groupings above in transferring findings to non-sampled local authorities.

The final analysis used in the current study used a combination of information on kerbside services and nearest neighbour analysis, which is described in Section 5.3. It's likely the principle benefit of this approach is the application of a single local authority kerbside profile (using a service and demographic component), to a matched local authority. However, the methodology is relatively time consuming and less repeatable, both as a qualitative judgement and as the "best" match may change over time. Further, it was only practical given the relatively small number of local authorities where we did not have waste composition data.

Probably the most significant limitation we identified with our approach to identifying a "best" match was an over-reliance on residual waste composition from a single local authority with no kerbside garden waste service. If a similar approach was adopted in any future study, it would benefit from considering the full range of kerbside services in place at each local authority. Future studies may also wish to ensure that local authorities with reduced residual waste capacity are sampled.

6.4 Composition data for mixed food and garden waste collections

Our review of mixed food and garden waste composition studies used in the current analysis highlighted a reliance on a relatively small number of compositional analysis conducted as a single phase in spring, but those analysis are reasonably consistent with other studies.

As a number of local authorities have move to mixed food and garden waste services, there may be a need to generate new composition profiles using an increased number of sampling points, in order to improve the accuracy of any standard assumptions that are applied to mixed food and garden waste. This is significant for a number of related issues, including monitoring of Scotland's food waste reduction target.

6.5 The use of waste data flow datasets in national composition estimates

The methodology described in this document is very reliant on the data reported by local authorities on waste data flow. The quality and content of the waste data flow dataset therefore has a direct impact on the quality of any national-scale waste composition study.

Overall we found the waste data flow dataset clear, consistent and relatively easy to work with[21]. The process of combining waste composition data with waste data flow datasets identified a number of relatively minor issues with how data is reported by individual local authorities on waste data flow (see Section 4.3). For the purposes of this study we were able to resolve almost all our queries with the local authority direct, and historically we think this may have been the solution adopted by waste composition contractors. In the longer term there is probably a good opportunity for Zero Waste Scotland to liaise with SEPA to prioritise some of these issues, in order to improve the quality of any future waste composition study.

It is also worth highlighting that national waste composition studies are a key "user" of the current waste data flow dataset, and any changes to local authority reporting would benefit from considering the needs of a similar study in future.

7 Appendix

In the table below the first two columns from left list the Level 1 and 2 material categories used in waste composition studies and national estimates of kerbside composition. Analysis of the recyclable content of kerbside residual waste uses the "Typically recycled at the kerbside" categorisation in the third column from left. For example, within the group "Glass", green, brown and clear container glass are typically collected for recycling at the kerbside, but non-packaging glass is not. Our analysis of the biodegradable content of residual waste uses the assumptions in the fourth column from left.

Level 1 category	Level 2 category	Typically recycled at the kerbside category	Biodegradability content assumption
Glass waste	Green container glass	Glass	0%
Glass waste	Brown container glass	Glass	0%
Glass waste	Clear container glass	Glass	0%
Glass waste	Non-packaging glass	Not recycled kerbside	0%
Paper and cardboard	Newspaper, magazines	Paper	100%
Paper and cardboard	Other Recyclable Paper	Paper	100%
Paper and cardboard	Non-recyclable Paper	Not recycled kerbside	100%
Paper and cardboard	Board Packaging	Card	100%
Paper and cardboard	Thin Card Packaging	Card	100%
Paper and cardboard	Other Card	Card	100%
Paper and cardboard	Books	Paper	100%
Paper and cardboard	Yellow Pages/Directories	Paper	100%
Paper and cardboard	Cardboard beverage packaging / cartons	Cartons	50%
Metal - ferrous and non-ferrous	Cans - steel	Metals	0%
Metal - ferrous and non-ferrous	Cans - Aluminium	Metals	0%
Metal - ferrous and non-ferrous	Aluminium packaging	Metals	0%
Metal - ferrous and non-ferrous	Other Scrap metal	Not recycled kerbside	0%

Level 1 category	Level 2 category	Typically recycled at the kerbside category	Biodegradability content assumption
Metal - ferrous and non-ferrous	Aerosols - Aluminium	Metals	0%
Metal - ferrous and non-ferrous	Aerosols - steel	Metals	0%
Plastic bottles	HDPE drink bottles	Plastics	0%
Plastic bottles	PET drink bottles	Plastics	0%
Plastic bottles	Other plastic bottles	Plastics	0%
Dense plastic	Dense plastic packaging exc. EPS	Plastics	0%
Dense plastic	Expanded polystyrene packaging	Not recycled kerbside	0%
Dense plastic	Video tapes, DVDs and CDs	Not recycled kerbside	0%
Dense plastic	Other dense plastic - non-packaging	Not recycled kerbside	0%
Plastic film	Carrier Bags	Not recycled kerbside	0%
Plastic film	Bin Bags	Not recycled kerbside	0%
Plastic film	Other Plastic Film	Not recycled kerbside	0%
Garden waste	Green garden waste	Garden waste	100%
Garden waste	Woody and bulky garden waste	Garden waste	100%
Garden waste	Soil	Garden waste	0%
Food wastes	Avoidable food waste	Food waste	100%
Food wastes	Unavoidable food waste	Food waste	100%
Food wastes	Cooking oil/fats	Food waste	100%
Wood wastes - non-furniture and garden waste	Wood - treated	Not recycled kerbside	100%
Wood wastes - non-furniture and garden waste	Wood - untreated	Not recycled kerbside	100%
Wood wastes - non-furniture and garden waste	Chipboard and mdf	Not recycled kerbside	100%
Wood wastes - non-furniture and garden waste	Composite wood materials	Not recycled kerbside	50%
WEEE	WEEE - Large Domestic App	Not recycled kerbside	0%
WEEE	WEEE - Small Domestic App	Not recycled kerbside	0%
WEEE	WEEE - Cathode Ray Tubes	Not recycled kerbside	0%
WEEE	WEEE - Fridges & Freezers	Not recycled kerbside	0%
Tyres	Tyres	Not recycled kerbside	0%

Level 1 category	Level 2 category	Typically recycled at the kerbside category	Biodegradability content assumption
Miscellaneous combustible	Soft furniture	Not recycled kerbside	50%
Miscellaneous combustible	Wooden furniture	Not recycled kerbside	50%
Miscellaneous combustible	Bric-a-brac	Not recycled kerbside	50%
Miscellaneous combustible	Mattresses	Not recycled kerbside	50%
Miscellaneous combustible	Other combustible materials not otherwise specified	Not recycled kerbside	0%
Textiles & footwear	Clothing textiles	Not recycled kerbside	50%
Textiles & footwear	Shoes, belts & bags	Not recycled kerbside	50%
Textiles & footwear	Carpet & underlay	Not recycled kerbside	50%
Textiles & footwear	Non-clothing textiles	Not recycled kerbside	50%
Misc. non-combustible	Rubble	Not recycled kerbside	0%
Misc. non-combustible	Plasterboard	Not recycled kerbside	0%
Misc. non-combustible	Other construction and demolition waste	Not recycled kerbside	0%
Misc. non-combustible	Other non-combustible materials not otherwise specified	Not recycled kerbside	0%
Hazardous wastes	Fire extinguishers	Not recycled kerbside	0%
Hazardous wastes	Gas bottles	Not recycled kerbside	0%
Hazardous wastes	Ink & toner cartridges	Not recycled kerbside	0%
Hazardous wastes	Paint	Not recycled kerbside	0%
Hazardous wastes	Pesticides, varnish, inks and other chemicals	Not recycled kerbside	0%
Hazardous wastes	WEEE - Fluorescent tubes and other light bulbs	Not recycled kerbside	0%
Hazardous wastes	Mineral Oil	Not recycled kerbside	0%
Hazardous wastes	Automotive batteries	Not recycled kerbside	0%
Hazardous wastes	Non-automotive batteries	Not recycled kerbside	0%
Healthcare waste	Disposable Nappies	Not recycled kerbside	50%

Level 1 category	Level 2 category	Typically recycled at the kerbside category	Biodegradability content assumption
Healthcare waste	Other absorbent hygiene products	Not recycled kerbside	50%
Healthcare waste	Potentially hazardous healthcare waste	Not recycled kerbside	0%
Healthcare waste	Dead animals	Not recycled kerbside	100%
Healthcare waste	Pet excrement and bedding	Not recycled kerbside	100%
Fines (←10mm)	Fines (←10mm)	Not recycled kerbside	0%

8 Reference list

[1] http://www.zerowastescotland.org.uk/content/composition-municipal-waste-scotland

[2] For a more detailed analysis of the carbon impacts of Scotland's waste, including household waste, please see http://www.zerowastescotland.org.uk/research-evidence/2014-15-carbon-metric-summary-report.

[3] Based on the emissions solely associated with landfilling waste. For a more detailed analysis of the carbon impacts of Scotland's waste, including household waste, please see http://www.zerowastescotland.org.uk/research-evidence/2014-15-carbon-metric-summary-report.

[4] Based on 2014-15 landfill tax rate of £80 per tonne.

[5] The food waste tonnage for 2009 is taken from updated food waste estimates produced by ZWS in 2014.

[6] Services that targeted a small number of material types e.g cans and plastic.

[7] Readers interested in this information should go to the household recycling dataset, https://www.sepa.org.uk/environment/waste/waste-data/waste-data-reporting/household-waste-data/

[8] In relatively rare cases a waste type that we define as typically recycled at the kerbside nationally (e.g glass bottles) may not be targeted at the kerbside by a given local authority (i.e households are expected to use other non-kerbside recycling facilities).

[9] For example, clothing and textiles are commonly collected at bring banks, but not typically targeted at the kerbside.

[10] For example, only a percentage of households in a local authority area are provided with a given recycling service.

[11] Per person.

[12] For the separate food waste study see http://www.zerowastescotland.org.uk/sites/default/files/Household%20Food%20and%20Drink%20Waste%20Estimates%202014%20Final.pdf . This gives a more detailed breakdown of food waste arisings (including some non-kerbside routes). Estimates for food waste collected at the kerbside in the current study and the earlier study differ slightly due to slightly different scaling assumptions being used; these differences are highlighted in the respective methodology sections. We recommend the dedicated food waste study is preferred for discussion of food waste amounts, and the current study is preferred for discussion of kerbside collected waste and recycling in the round.

[13] During compositional analysis effort is made to separate wastes contained within carriers bags, bin bags and plastic film packaging, but we think it's unlikely that 100% can be removed in practice.

[14] Readers interested in the individual waste types defined as typically recycled at the kerbside should refer to the appendix of the separate methodology document.

[15] Typically via incineration and mechanical and biological treatment.

[16] e.g variation in householder utilisation of services, collection frequencies of all services, whether garden waste and glass waste are targeted at the kerbside.

[17] http://www.zerowastescotland.org.uk/content/composition-municipal-waste-scotland

[18] As highlighted in Section 2.3 our analysis is representative of a 2014-15 period. The national residual waste tonnage used in our analysis is very similar to, but will not exactly match those reported on waste data flow for either 2014 or 2015 reporting year.

[19] Based on the emissions solely associated with landfilling waste. For a more detailed analysis of the carbon impacts of Scotland's waste, including household waste, please see http://www.zerowastescotland.org.uk/research-evidence/2014-15-carbon-metric-summary-report.

[20] Based on 2014-15 landfill tax rate of £80 per tonne.

[21] The food waste tonnage for 2009 is taken from updated food waste estimates produced in 2014.

[22] At the time of waste composition studies in 2013-2015, four of the eighteen local authorities did not target glass for recycling at the kerbside, three did not collect food waste at the kerbside, and a single local authority did not target garden waste at the kerbside.

[23] In this case, if residual waste composition data represented households covered by a food waste service, but the local authority had only rolled out the service in part during 2014, we would normally have used 2015 waste data flow data in our analysis.

[24] Services that targeted a small number of material types e.g cans and plastic.

[25] http://www.zerowastescotland.org.uk/sites/default/files/Contamination%20in%20source-separated%20municipal%20and%20business%20recyclate%20in%20the%20UK%20report.pdf

[26] Excluding expanded polystyrene.

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