Final Report

Synthesis of Food Waste Compositional Data 2012

This report describes analysis of compositional data and WasteDataFlow information to produce estimates of food in local authority collected waste streams from UK homes in 2012.

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Front cover photography: Refuse vehicle, courtesy of Worcestershire Waste Partnership

Executive summary

Aim

The aim of this project is to produce estimates of the amount of food waste[1] collected by local authorities (LAs) from homes in the UK for 2012. The information in this report underpins a large proportion of the analysis for *Household Food and Drink Waste in the United Kingdom 2012*, published alongside this report[2].

Method

Data from waste composition studies carried out between 2011 to 2013 has been collated and analysed alongside the most recently available WasteDataFlow tonnages, in order to arrive at estimates of local authority collected household food waste levels in the UK. For the purposes of this project, local authority collected household food waste has been assumed to include food in the following household streams:

- Kerbside residual;
- Kerbside collections targeting food waste (separate food-waste collections and mixed-organics collections);
- Kerbside dry recycling (as contamination); and
- Household waste recycling centre (HWRC) residual waste.

Data on food waste arisings in kerbside residual – the most important waste stream to consider for this project – were obtained for 82 local authorities across the UK. The LAs with compositional studies were reasonably representative of the UK in terms of deprivation levels and population density; the sample was stratified by food waste collection system to account for differences between the sample and the population.

Results

The total amount of household local authority collected food waste in the UK in 2012 was 4,670,000 tonnes per year (±170,000 tonnes), or 175 kg / hh / yr (±7 kg / household / year)[3].

Waste Stream	Food waste arisings	
	Tonnes	kg / hh / year
Kerbside residual	4,036,540	150.9
Kerbside collections targeting food waste	537,471	20.1
Kerbside dry recycling (contamination)	43,812	1.6
HWRC residual	55,011	2.1
TOTAL	**4,672,835**	**174.7**

Note: the results quoted in the table are to the nearest tonne and 0.1 kg / hh / year for consistency with results in previous reports. However, due to the confidence intervals quoted (see Chapter 4), the level of precision around these results is much lower than implied: for this reason, they are quoted to three significant figures in the text.

[1] *Within this report, 'food' is used as a short hand for 'food and drink'. This includes: home compostable and non-home compostable; avoidable, possibly avoidable and unavoidable.*

[2] *Available from: www.wrap.org.uk/household-food-waste*

[3] *Approximate 95% confidence intervals are quoted, see Chapter 13 in Methods Annex Report for more details of uncertainty.*

Contents

Glossary

- Defra – Department for Environment, Food and Rural Affairs
- HWRC – Household Waste Recycling Centre (also known as a civic amenity site)
- LA – Local authority
- WDF – WasteDataFlow, a reporting system for waste collected by local authorities in the UK (http://www.wastedataflow.org/)
- WRAP – Waste and Resources Action Programme

Shorthand used in this report for previous reports in this area:

- The 2010 study: *Synthesis of Food Waste Compositional Data 2010* www.wrap.org.uk/sites/files/wrap/Synthesis%20of%20Food%20Waste%20Compositional%20Data%202010%20FINAL.pdf
- Defra WR0119: *Municipal Waste Composition: Review of Municipal Waste Component Analyses* http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=15133
- Defra EV0801: *Defra EV0801 National compositional estimates for local authority collected waste and recycling in England, 2010/11* (currently not published)

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1.0 Introduction

1.1 Background

A key objective for WRAP is to support and enable efforts to reduce the quantity and environmental impact of household food waste across the UK, working in partnership with a wide range of organisations including local authorities (LAs), grocery retailers and food manufacturers and community groups. It is therefore necessary to quantify household food waste in the UK in order to track progress and to understand the impact of work to date.

The primary aim of this project is to produce estimates of food waste[4] collected by local authorities from UK homes using the most recent data available. The main body of the report describes the analysis and results relating to estimates for 2012. The definition of food waste used in this study is in §1.2, the methodology is found in Chapter 2.0, and the results in Chapter 4.0. This project is similar to the study *Synthesis of Food Waste Compositional Data 2010* (hereafter referred to as 'The 2010 study'), which produced estimates of food waste collected by local authorities from UK households for 2010.

It is also of key importance to WRAP in assessing how the level of food waste has changed in recent years. Therefore, estimates have also been produced for 2009 (Appendix 2), that are as comparable as possible with the results for 2012 presented in the main body of this report (2009 is the baseline year for the second phase of the Courtauld Commitment[5]).

Both the 2009 and the 2012 estimates combine information from a range of years around a 'reference' year: these are referred to in the report as "pooled" estimates. The main advantage of the pooled estimates is that they each use a relatively large number of studies, thus reducing the uncertainty in each estimate. In addition to these pooled estimates, estimates of food waste arisings from 2006 to 2012 based solely on information from each year are also calculated; these are referred to as 'single-year' estimates (Appendix 3). The single-year estimates were generated as a check of the pooled estimates, specifically that no spurious effects resulted from using data from a range of years. These single-year estimates also provide more information about when changes in household food waste occurred.

The research summarised in this report sits within a wider programme of research to assess recent changes in household food waste in the UK. This wider research is described alongside how information from the current study is used in a separate report on methods (*Method Annex Report*).

1.2 Definition of local authority collected household food waste

The focus of this study is **household** food waste collected by local authorities. For the purposes of this report, this is defined as food waste which is likely to have been generated from within the household: i.e. from food that was purchased (or otherwise taken into the home) or home grown and then either some or all of it disposed to a local authority collection. It includes food found in kerbside waste streams and those associated with household waste recycling centres (HWRCs). There are some data on food waste in other municipal waste streams, such as street sweepings and litter (§4.4), but these are excluded from the estimate of household food waste. Although street sweepings and litter are classified as part of the household waste stream within WasteDataFlow (WDF)[6], they have

[4] *Within this report, 'food' is used as a short hand for 'food and drink'.*

[5] *www.wrap.org.uk/courtauld*

[6] *WasteDataFlow is a reporting system for waste collected by local authorities in the UK (http://www.wastedataflow.org).*

been excluded from the estimates presented in this report as it is assumed that the food waste found in these streams is less likely to have come from food that had entered a household.

Given the above, **local authority collected household food waste** is classified, for the purposes of this study, as that found within the following streams:

- **Kerbside residual:** i.e. 'general' waste collected from the households.
- **Kerbside collections targeting food waste:** this includes collections from households of either separate food waste or mixed garden and food waste. This collected material is diverted from either landfill or energy from waste. The treatment process usually consists of in-vessel composting, although a growing fraction of this material is sent to anaerobic digestion and other treatment methods. For the purposes of brevity, this waste stream is hereafter referred to as 'collections targeting food waste'.
- **Kerbside dry recycling:** food waste contamination of kerbside dry recycling collections from households.
- **Household Waste Recycling Centre (HWRC) residual waste.**

It was found that negligible quantities of food waste collected for treatment were reported for HWRCs in the UK and therefore the HWRC recycling stream has not been considered in this study. In previous reports, WRAP has quantified food waste that is disposed down the sewer (via the kitchen sink), home composted or fed to animals. This report does **not** quantify any of these disposal routes, but they are reported in *Household Food and Drink Waste in the United Kingdom 2012*.

In addition, some previous studies of local authority collected food waste have included an estimate of food waste arising in fines (small particulate material) in residual waste streams. An estimate of food waste in fines is also omitted from this study due to a lack of robust data. Where comparisons are made with previous estimates that included food waste in fines, adjustment has been made of the historical data to make the comparisons more robust.

The material reported as food waste in this report includes:

- **Avoidable**: food and drink thrown away that was, at some point prior to disposal, edible (e.g. slice of bread, apples, meat).
- **Possibly avoidable**: food and drink that some people eat and others do not (e.g. bread crusts, potato skins).
- **Unavoidable**: waste arising from food or drink preparation that is not, and has not been, edible under normal circumstances (e.g. meat bones, egg shells, tea bags)[7].

This study calculates the total arisings of these three fractions of food waste. A summary of the relative arisings of these fractions in kerbside food waste, deduced from the compositional data collated for this study, is provided in §4.3.

[7] *As defined in* Household Food and Drink Waste in the UK. http://www.wrap.org.uk/retail_supply_chain/research_tools/research/report_household.html

2.0 Methodology

2.1 Introduction

The study employs a similar methodology to the *Synthesis of Food Waste Compositional Data 2010* study[8] to calculate estimates of household food waste in the UK collected by local authorities. It has involved analysing waste compositional data alongside WDF tonnages, for kerbside residual, kerbside dry recycling, collections targeting food waste and HWRC residual. The baseline period for this study is 2012 and was as closely aligned to the calendar year 2012 as was possible at the time the analysis was carried out.

Many local authorities in the UK have commissioned studies to examine the waste they collect or that is collected on their behalf by waste contractors. These compositional studies classify the waste into different materials, usually between 15 and 40, depending on the detail required and the amount to be sorted. Food waste is usually one of these categories and sometimes this is further subdivided: e.g. home compostable / non-home-compostable; packaged / non-packaged. It should be noted that the householder's details were not linked to the waste collected and it is not possible to identify the household within the published data.

In this study, data has been collated from a range of compositional analyses undertaken by different local authorities. This data has been analysed alongside information from WDF relating to the weight of material in different waste streams. WDF information includes quantities for individual waste streams and materials. Once checked by the organisations overseeing WDF, the data is published and can be used in these synthesis studies, often negating the need for all waste streams to be sampled: for instance, local authorities which have separate food waste collections will usually record the amount in the correct category in WDF and therefore do not need further measurement to determine the quantity of food in this waste stream. (For comments on contamination in food waste collected for treatment, refer to §2.5.5.)

However, the type of materials present in the residual waste streams are not recorded in WDF. To obtain an estimate of the amount of food in each residual stream, the percentage of food waste in a stream (as measured by the local authority compositional analysis studies) is applied to the total weight of that residual stream from WDF.

2.2 Previous estimates

The analysis described here uses similar methods to previous work in this area, the 2010 study. The waste streams considered in the 2010 study were:

- Kerbside residual;
- Kerbside collections targeting food waste;
- Kerbside dry recycling (contamination consisting of food waste); and
- HWRC residual.

The 2010 study assessed arisings for the baseline period of 2010, although the 12-month period for WDF tonnages used in the analysis was the latest available at the time that the project was carried out, namely October 2009 to September 2010.

The estimates produced for 2010 were pooled estimates, in that they included waste compositional studies (mostly for kerbside collected waste) carried out between 2009 and

[8] www.wrap.org.uk/sites/files/wrap/Synthesis%20of%20Food%20Waste%20Compositional%20Data%202010%20FINAL.pdf

2011. These studies included a combination of single and multi-phase audits. For multi-phase studies, the year of auditing was defined in terms of the mid-point of all the periods of auditing. Some of the 2009 multi-phase audits included one or more phases in 2008.

The rationale for including audits from either side of the baseline year for the 2010 pooled estimates was that this would significantly increase the number of compositional studies that could be included in the analysis, which would reduce the size of the confidence intervals around the estimates. This rationale also applies for other pooled estimates including the 2012 pooled estimates (§2.3), and the 2009 pooled estimates in Appendix 2.

However, the inclusion of data outside the baseline period reduces the degree to which compositional analysis data correspond to the baseline period. For instance, in the 2010 study, information from 2009 on the proportion of food waste in the residual waste stream was being applied to the total amount of residual waste in 2010; if there were significant changes in waste arisings or collections, this would lead to small errors in the results.

By contrast, the single-year estimates are specifically related to compositional data for the year in question. A comparison of the outputs from the pooled and single year estimates is presented in Appendix 3.

The coverage of compositional studies analysed in the 2010 study in terms of period of auditing, waste stream audited and nation is summarised in Table 1. For the 2010 study, results were compared with estimates for England 2006/07 from the *Defra WR0119* project[9].

Table 1: Coverage of compositional studies by waste stream, period and nation for the 2010 study

		2007	2008	2009	2010	2011	*Single-phase*	*Multi-phase*	Total
England	Kerbside residual			16	27	5	*32*	*16*	**48**
	Kerbside dry recycling			8	9	3	*13*	*7*	**20**
	HWRC residual			5	3	0	*5*	*3*	**8**
Wales	Kerbside residual			21	0	0	*0*	*21*	**21**
	Kerbside dry recycling			21	0	0	*0*	*21*	**21**
	HWRC residual			21	0	0	*0*	*21*	**21**
Scotland	Kerbside residual			10	3	1	*12*	*2*	**14**
	Kerbside dry recycling			9	1	0	*1*	*9*	**10**

[9] *Defra WR0119 Municipal Waste Composition: Review of Municipal Waste Component Analyses, Resource Futures, 2009.* http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=15133

		2007	2008	2009	2010	2011	*Single-phase*	*Multi-phase*	Total
	HWRC residual			9	0	0	*0*	*9*	**9**
Northern Ireland	Kerbside residual	6	0	0	0	0	*0*	*6*	**6**
	Kerbside dry recycling	6	0	0	0	0	*0*	*6*	**6**
	HWRC residual	0	0	0	0	0	*0*	*0*	**0**

2.3 Compositional datasets included in the 2012 pooled estimates

The compositional data being considered here is largely based on the same group of datasets that have been analysed by Resource Futures on behalf of Defra to produce updated estimates for the composition of local authority collected waste in England for 2010/11 (*Defra EV0801 National compositional estimates for local authority collected waste and recycling in England, 2010/11*).

This dataset has been supplemented by subsequent waste compositional analyses that have been collated specifically for the current project, with a significant number of new datasets from English local authorities, alongside datasets from Scotland and Wales; none was available from Northern Ireland.

The datasets compiled for the current study were assessed to determine whether socio-demographic stratification of samples had been carried out, with the aim of obtaining samples that were reasonably representative of the socio-demographic profile of the relevant local authority. Only those datasets meeting this criterion where included in the study. This criterion was met by the great majority of collated datasets.

The 2010 study and the current study have included kerbside compositional datasets from both single-phase and multi-phase audits. This is in contrast to the compositional estimates for England 2006/07 produced in the *Defra WR0119* study, which only included multi-phase audits for kerbside compositional datasets, due to so many datasets being available for the 2006/07 baseline. The inclusion of only multi-phase studies for the *Defra WR0119* study was intended to control for seasonal variation in arisings of various components in the kerbside stream.

The WRAP 2010 study took the decision to include single-phase studies, due to a drop off in the number of compositional studies that had been commissioned since the *Defra WR0119* study. For the WRAP 2010 study an assessment was made of seasonal variations in food waste through analysing separate phase data from multi-phase studies used for the England 2006/07 estimates in the *Defra WR0119*. This assessment concluded that although some seasonal variation was apparent in food waste arisings in kerbside waste, these were relatively minor. For the current study, an updated assessment of seasonal variation in food waste arisings has been carried out using more recent data (Appendix 1).

For the current study, multi-phase audits have been split into their individual phases. The most important advantage of this approach is that it has increased the number of data points

that can be included for the purposes of producing updated UK estimates, thus increasing the size of the sample available for analysis.

The 2010 study did not split multi-phase data into constituent phases in this manner, and did not give greater weighting to the more comprehensive multi-phase audits, which would have provided a better reflection of the quality of information contributed by such audits to the sampled dataset, in comparison to single-phase studies. The procedure of splitting multi-phase studies into constituent single phases for the current study overcomes this problem and effectively provides greater weighting to multi-phase studies. However, this approach means that the dataset for the current study includes studies that sample households in the same areas (i.e. from the same collection rounds, although not necessarily exactly the same households). Given that some households may have been sampled more than once, this may lead to a small bias in the results.

However, it is considered that the advantages of using a greater number of data points through splitting multi-phase datasets is a more important consideration in selecting the approach to conducting the analysis. The splitting of multi-phase audits into single-phase data has also provided more flexibility in matching waste audit data to the relevant WDF information. Furthermore, the effect of splitting multi-phase datasets on the 2012 results is small.

The coverage of kerbside residual compositional data by period is shown in Table 2, with multi-phase studies disaggregated into their constituent phases, and this data combined with the single phase studies. The data refers to datasets for kerbside residual composition for districts in England. A distinction is made in Table 2 between data included in the production of the 2010 estimates and data subsequently collated, with additional collation carried out during the *Defra EV0801* project and the current project. The *Defra EV0801* project includes all the data referred to in Table 1 and managed to obtain some earlier studies (i.e. pre-2010), as well as a significant number of more recent studies.

Table 2: Coverage of disaggregated phase data for kerbside residual compositional data in the UK (from the current research and the 2010 study).

Calendar year	2008	2009	2010	2011	2012	2013
No. phases included in 2010 study						
England	2	20	43	14	0	0
Wales	0	42	0	0	0	0
Scotland	0	12	5	1	0	0
Northern Ireland	0	0	0	0	0	0
No. phases collated since 2010 study						
England	17	5	14	41	29	6
Wales	0	0	0	2	0	0
Scotland	0	0	0	1	2	1
Northern Ireland	0	0	0	0	0	0
All phases collated across both studies	**19**	**79**	**62**	**59**	**31**	**7**

For the WRAP 2010 study, data on arisings of food waste in kerbside waste was checked for outliers, in order to identify unusually low or high estimates of food waste arisings. Only a few outliers were identified and these were removed from the dataset that was subsequently analysed. A similar procedure was carried out for the kerbside compositional datasets compiled for the current study, although no outliers were identified.

In terms of kerbside waste audit data, only data from January 2011 onwards and which were *not* used in the 2010 pooled estimates have been included in the current analysis. This ensures that the 2012 pooled estimates are based on a distinct set of data from the 2010 pooled estimates. This means that the datasets for 2010 and 2012 are independent, permitting valid statistical tests of differences between these two periods to be performed. The coverage of kerbside composition datasets thus included is shown in Table 3.

Table 3: Coverage of kerbside residual compositional data by year, for the 2012 pooled estimates

Calendar year	2011	2012	2013
England	41	29	6
Wales	2	0	0
Scotland	1	2	1
Northern Ireland	0	0	0
All datasets	**44**	**31**	**7**

For the 2012 UK estimates, the coverage of the sample (i.e. all the districts with an audit of kerbside residual waste) compared to the UK as a whole has been assessed against several key criteria (Chapter 3.0).

In addition to producing 2012 pooled estimates, this study has carried out an analysis of kerbside food waste arisings (i.e. in residual waste and collections targeting food waste) for the UK and England by calendar year from 2006 to 2012 to produce single-year estimates (Appendix 3). This analysis has included data used in the 2010 study and *Defra WR0119*. If more than one dataset was available for a district within a particular calendar year, the average food waste arising in kerbside residual across all the relevant studies was used. The numbers of kerbside residual compositional datasets included in the single-year analyses are shown in Table 4.

Table 4: Coverage of kerbside residual compositional data by year, for the single-year estimates

Calendar year	2006	2007	2008	2009	2010	2011	2012
England	55	59	31	24	50	36	31
Wales	0	0	0	22	0	1	0
Scotland	0	0	0	8	4	1	2
Northern Ireland	0	6	0	0	0	0	0
All datasets	**55**	**65**	**31**	**54**	**54**	**38**	**33**

Coverage for other waste streams (kerbside dry recycling, kerbside organics and HWRC residual) was poorer, with fewer compositional datasets available.

2.4 WasteDataFlow (WDF) time period used for analysis

The 2010 study used the latest baseline period (i.e. time period of information from WDF) available at the time of analysis, which was the 12-month period October 2009 to September 2010. For the current study, and for the purpose of producing a UK estimate for 2012, a period exactly 2 years later has been used as the baseline, i.e. October 2011 to September 2012 (again, the most recent available at the time of analysis). This corresponds to the latest available WDF tonnages for England at the time that this study was carried out. However, for Northern Ireland, Scotland and Wales the most recent 12 months of WDF information that were published at the time of writing were slightly older:

- Wales: April 2011 to March 2012;
- Scotland: January 2011 to December 2011; and
- Northern Ireland: April 2011 to March 2012.

This data has been used as a proxy for October 2011 to September 2012 in the absence of more recent information.

2.5 Household waste arisings calculation method

The 2010 study used two methods for calculating UK household waste arisings, a 'standard' method and an 'alternative' method, with the standard method being the methodology used to produce the final estimates. These are outlined in the section below and compared in §2.5.4.

For consistency with the 2010 estimates, the standard method has been used for the current study. However, the alternative method has also been applied, in order to understand how the calculation method impacts on the results (Appendix 3).

2.5.1 "Standard method" for calculating UK estimates

A similar methodology has been used in the current study as for the 2010 study and production of household waste compositional estimates for England (*Defra WR0119* for England 2006/07; and *Defra EV0801* for England 2010/11). As well as disaggregation of multi-phase studies, there has been one other amendment to the methodology: adjustment for the different yield of collections targeting food waste, described in §2.5.2. The methodology consists of the following stages:

Kerbside residual: the weight of food waste is determined by taking the proportion of kerbside residual waste that is food from each of the waste compositional studies. From this information, an average proportion is calculated and multiplied by the amount of residual waste collected in the UK. As a refinement to this method, the population of local authorities is divided into two 'strata' depending on whether the local authority collects food waste in targeted collections. For each strata, the proportion of residual waste that is food is calculated; this stratification approach therefore takes into account the lower proportion of food waste in the residual bin for those local authorities collecting food waste for treatment (§2.5.2). This stratification is used when considering kerbside residual and kerbside collections targeting food waste; it is not applied to calculations for kerbside dry recycling and HWRC residual for two reasons. Firstly, there are too few data points to allow effective stratification; secondly, the interaction in food waste between these two waste streams and kerbside collections targeting food waste is not known. Given the minor contribution of HWRC residual and kerbside dry recycling to household food waste estimates, this decision is unlikely to have a substantial impact on the results.

Kerbside collections targeting food waste: the total food waste arising across all local authorities in the UK is estimated from WDF data, as described in §2.5.5.

Kerbside dry recycling: a similar procedure to kerbside residual is carried out for kerbside dry recycling: where compositional data identifies food waste contamination in kerbside dry recycling (data from 14 studies), this is used to arrive at an average proportion of the dry recycling waste stream that is food. This average proportion is multiplied by the total amount of dry recycling collected in the UK to arrive at an estimate of food waste in kerbside dry recycling.

HWRC residual: a similar procedure as for kerbside residual and kerbside dry recycling is applied to arrive at an estimate of UK arisings of food waste in HWRC residual (data from 12 studies).

The sum of food waste arisings across these four household waste streams is then calculated to arrive at a tonnage estimate of UK arisings of local authority collected household food waste.

2.5.2 Stratification of the standard method in the current research

The degree to which the collated studies are representative of local authorities in the UK is assessed in Chapter 3.0. Importantly for the analysis, it is found that local authorities with collections targeting food waste were slightly over-represented (§2.5.5). This means that the sample is skewed towards local authorities which tend to have slightly lower food waste arisings in kerbside residual, due to some food waste being diverted to targeted collections. To account for this in the analysis, the sample and population are stratified by presence of collections targeting food waste.

From the testing of different stratification approaches in the 2010 study, it has been found that the most robust approach is to place local authorities into two strata according to whether or not they had collections targeting food waste. Each strata contained reasonable numbers of authorities and, furthermore, there was a large difference in the amount (per household) and proportion of food waste in the residual waste between these two strata. For example, for the local authorities in the sample with collections targeting food waste, there was on average 30% food waste in the residual stream (or 127 kg / household / year); for those authorities in the sample without collections targeting food waste, the corresponding figures were 35% and 167 kg / household / year. Similar figures were obtained in the current study.

Therefore, stratification helps the standard methodology account for the effects of collections targeting food waste. Furthermore, stratification improves the precision of the final estimates by grouping similar local authorities together, reducing the variability between them.

After this stratification, one remaining effect is that the level of diversion of food waste from the residual stream to collections targeting food waste varies greatly (when assessed on a per household basis and averaged over the whole local authority). This could be for a number of reasons including different coverage of collections targeting food waste within each local authority, and different participation and capture rates for those areas covered. However, the stratification method above places all local authorities that collect some food waste in targeted collections in a single stratum, irrespective of the level of diversion.

For local authorities offering targeted collections, if the average level of diversion is similar (per household) for those local authorities in the sample (i.e. with a compositional analysis) compared to the population, then this is likely to have only a negligible effect on the results. However, in 2009 and 2010, the amount of food waste collected in targeted collections in the sample was higher (per household) than in the population; in 2012 the converse was true. This leads the standard method to slightly underestimate the amount of food waste in the residual in 2009 and 2010, and overestimate it in 2012.

Given the above, two methods have been investigated to correct for this effect:

Calculation of an adjustment factor: This method calculates the average amount of food waste in collections targeting food waste for a) authorities with a waste compositional analysis, b) authorities without a waste compositional analysis. This is possible because data on food in collections that target food waste comes from WasteDataFlow rather than compositional analyses. (By way of example, in 2012, the amount of food in targeted collections was 37.8 kg per household for authorities with a waste compositional analysis and 44.5 kg per household for those without a waste compositional analysis.)

The difference in these average yields is used to calculate the additional amount of food waste that has been diverted to collections by those authorities without a waste compositional analysis. (For 2012, 6.7 kg per household equates to 76,000 tonnes extra collected by local authorities outside the sample.) This is then subtracted from the amount in the kerbside residual waste to correct for the overestimate (in the case of 2012). This method assumes that the total level of food waste in kerbside waste streams is independent of the presence of collections targeting food waste; this assumption is backed up by recent research on the relationship between food waste collection and prevention[10].

More detailed stratification: this method further stratifies the population of local authorities – it divides those authorities collecting food waste into three strata according to the amount of food waste collected in targeted collections. (This leads to a total of four strata when those not targeting food waste in collections are taken into account.) The calculations described in §2.5.1 are then performed on each of the strata in turn. Three strata were chosen as this allowed sufficient studies to be included in each, and the thresholds of each stratum were determined to ensure approximately equal numbers of studies in each.

Although this method has the advantage of allowing the uncertainty associated with the adjustment to be calculated, it gave some unexpected results. For 2012, the adjustment was in the opposite direction than expected, which is probably due to a relatively weak relationship between the amount of food waste collected in kerbside waste streams and the proportion of food waste in the residual waste stream. (The relationship is weaker than that between amount of food waste in the targeted collections and amount in the residual, which the first method relies on.)

Given the above, it was decided to adjust the data using the first of the two methods, and this is applied to 2009, 2010 (retrospectively) and 2012 estimates. The "alternative method"

10Two pieces of WRAP research focus on this topic:

Effect of food waste collections on arisings: recent evidence (WRAP, 2013): *http://www.wrap.org.uk/sites/files/wrap/Effect%20of%20food%20waste%20collection%20on%20arisings%20WRAP%20UK_0.pdf*

Literature Review - Relationship between Household Food Waste Collection and Food Waste Prevention (WRAP, 2011): *http://www.wrap.org.uk/sites/files/wrap/Impact_of_collection_on_prevention_FINAL_v2_17_8_11.33a4f2d0.11159.pdf*

(§2.5.3) does not suffer from this effect as it sums the food waste in the residual and targeted collections before extrapolating to local authorities outside the sample.

In addition to this diversion effect, there is the potential for collections targeting food waste to affect the total quantity of food waste generated (e.g. a prevention effect). However, the direct evidence for this effect is limited[11], and there is considerable uncertainty about its magnitude and what factors influence it (e.g. frequency of residual collections).

Given the methodology adopted, the analysis removes most distortions in the estimates emanating from over-representation in the sample of local authorities targeting food waste for collection.

2.5.3 "Alternative method" for calculating UK estimates

The alternative grossing up methodology essentially consists of:

- Calculating the arisings per household of the food waste fraction of kerbside residual waste and collections targeting food waste fractions for each of the local authorities included in the study;
- Calculating the average arisings of food waste, in terms of kg / household / year, across all the local authorities included in the study; and
- Multiplying the mean arisings of food waste kg / household / yr by the number of UK households.

Food waste in the kerbside dry recycling and HWRC streams is calculated separately and added to the estimates for kerbside residual waste and collections targeting food waste. This separation is necessary as there are too few studies with data for all four waste streams to be able to calculate a meaningful average. A discussion of the "alternative method" and a comparison of findings for the alternative and standard methods are provided in Appendix 3.

2.5.4 Discussion of alternative and standard methods

The two methods have been used to generate results to ensure that artefacts from the calculations are not substantially influencing the results. For 2012, as with most years, the two methods produce similar results (see Table 20 in Appendix 3): the alternative method produces an estimate 1.7% lower for food waste in the kerbside residual stream, which leads to an estimate 1.5% lower for all local authority collected food waste.

The standard method has the advantage that it builds up the calculation for each individual waste stream. For example, if there is only data for the kerbside residual stream for a local authority – which is often the case – this allows the proportion of food waste in this stream to be calculated. In contrast, the alternative method requires information for all waste streams included in the calculation – kerbside residual and kerbside collections targeting food waste. This means that food waste in targeted collections must be calculated for the alternative method to function, even if there is a great deal of uncertainty in the result. This is the case for local authorities that reported kerbside organic waste ambiguously or where the split of garden and food in mixed collections was not directly measured.

However, the alternative method has the advantage that it directly takes into account the diversion effect of collections targeting food waste. For the standard method to function correctly stratification and adjustment is required to circumvent this issue. Furthermore, the

[11] *See previous footnote.*

alternative method also takes into account the effect on total kerbside residual waste of, for instance, different levels of kerbside dry recycling. (Currently, no adjustments are made in the standard method to account for difference in total amount of kerbside residual waste between the sample of local authorities and the whole population.)

On balance, the advantages and disadvantages of each method are of similar magnitudes, and they produce similar results. Given the historic use of the standard method in WRAP estimates of household food waste, and the use of the method by research commissioned by Defra (e.g. *Defra WR0119*), this is the method that has been used in the current research.

2.5.5 Food Waste in kerbside collections targeting food waste

WDF includes a number of categories for describing organic waste collected at the kerbside for treatment. These tonnages have been analysed to produce estimates for food waste collected for treatment for all authorities, wherever food waste is targeted. The following WDF categories are relevant:

- **Waste food only**: this category is straightforward as the vast majority is food waste[12], and it is also an important indicator of the presence of separate food waste collections.
- **Mixed garden and food waste**: this category is less easily dealt with as the proportion of food waste in this material cannot be determined directly from the WDF tonnages. The food waste element is calculated as described below.
- **Other compostable waste**: this category is highly uncertain as it could consist of garden waste, food waste or mixed food and garden wastes. For authorities reporting tonnages in this category reference has been made to data on kerbside organics recycling schemes from WRAP's annual audit of collection schemes.

For mixed garden and food waste streams, where separate audit data is available for kerbside organics (from the collated waste compositional data) the proportion of food waste has been determined with reference to the audit data for that authority. However, this data is only available for a few authorities and it has been necessary to make a generic assumption for the other authorities with such collections. These assumptions are based on audits of mixed kerbside organics collections collated for the *Defra EV0801* national estimates for England 2010/11, and include audit data from different seasons in order to control for seasonal variation in the garden waste fraction of mixed garden and food waste collections.

The WRAP report *Performance analysis of mixed food and garden schemes* (2010)[13] shows that food waste yields in mixed organics collections are significantly different for weekly and fortnightly schemes. This is also indicated by audit data collated for *Defra EV0801*. Therefore, separate assumptions for food waste as a proportion of mixed food and garden waste collection tonnages have been applied for weekly and fortnightly schemes, as follows:

- 21.2% for weekly organics collections; and
- 14.7% for fortnightly organics collections.

The allocation of food waste for local authorities reporting in the "other compostable waste" category is the most challenging, as the category could consist of various combinations of

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[12] *A small amount of the material collected as food waste consists of contamination. An analysis of 6 waste composition datasets of separate food waste collections indicates an average contamination rate of 1-2%. However, this represents a relatively small amount of material and contamination rates have not been accounted for in the analyses presented in this study; neither were they accounted for in the previous 2010 study. Therefore, this study assumes that 100% of this stream is food waste.*

[13] http://www.wrap.org.uk/sites/files/wrap/Food_Garden_Waste_Report_Final.pdf

targeted materials, with different combinations of garden waste, cardboard and food waste. Sometimes, separate food waste collections or mixed garden and food waste collections are reported in this category (when the authority should more correctly have reported this material under the relevant category described above). The materials targeted for authorities reporting "other compostable waste" tonnages are ascertained with reference to the WRAP data on kerbside scheme types (mentioned above). The amount of food has been estimated on the basis of the combination of materials targeted and the collection frequency, through reference to composition data from corresponding schemes.

2.6 Household counts and Confidence Intervals

The methodology for determining the number of households for each local authority in the UK for this analysis is described in the *Methods Annex Report*, Chapter 7. The number of households does not affect the main pooled estimates presented in this report (§2.5.1), although it does affect some of the other estimates produced.

Confidence intervals have been calculated for the main estimates in the report. These include contribution from sampling errors: i.e. emanating from a sample of local authorities completing waste audits. For each waste stream, where sampling forms part of the estimation process (kerbside residual, kerbside dry recycling and HWRC residual), the variation in the percentage of that waste stream that is food is used to construct the confidence interval.

For the kerbside residual stream, the confidence intervals have been calculated for each stratum (local authorities with collections targeting food waste and local authorities without such collections). These two confidence intervals are then combined to give an overall confidence interval. The confidence interval for these three waste streams has then been combined to give an overall estimate of confidence, quoted at the 95% confidence level[14].

These confidence intervals omit contributions from systematic errors, which are usually difficult to quantify and / or combine with sampling errors. However, systematic errors are discussed in *the Methods Annex Report* (Chapter 13).

[14] *Combining confidence intervals in this way assumes that the estimates and their uncertainties are independent. Where audits have measured waste in multiple streams within the same local authority, there may be some correlation between the uncertainties calculated, but the effect on the overall confidence intervals (which are dominated by the kerbside residual waste stream) is likely to be small.*

3.0 Coverage assessment

The coverage assessment presented here relates to the pooled 2012 estimates for the UK. Coverage assessments are carried out in respect of levels of deprivation (§3.1), region and nation (§3.2), population density (§3.3), collection system (§3.4), to assess the degree to which the local authorities represented in the study are representative of all local authorities in the UK. The assessment focuses on the coverage of studies with data on food waste arising in kerbside residual, which is the most important waste stream for food waste. Assessments of the coverage of studies over time is also included in this study and the waste streams for which audit data is available (§3.5).

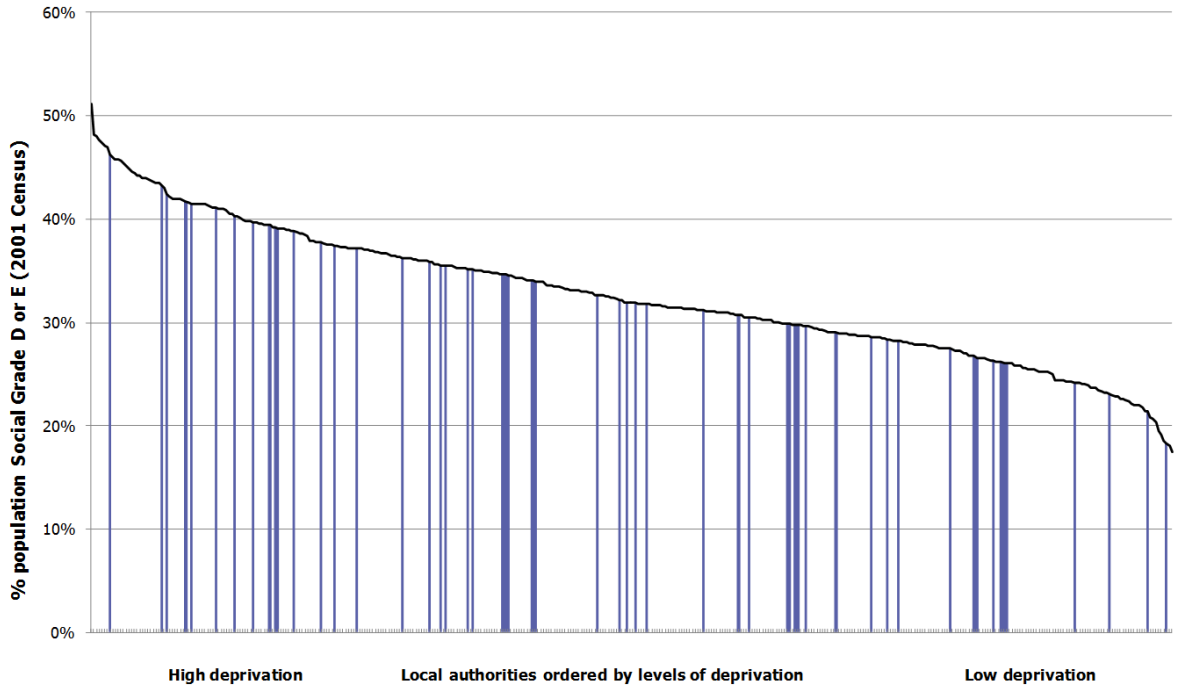
3.1 Coverage by levels of deprivation

Coverage in terms of levels of deprivation is illustrated for UK local authorities in Figure 1. Indices of Multiple Deprivation are also available for all the UK nations, but unfortunately these indices are not mutually comparable between nations. One way around this problem is to measure levels of deprivation in terms of the proportion of the population found to be of Social Grade D or E in the 2001 Census[15]. This is not an ideal method, since this data is now somewhat out of date. However, an analysis comparing this measure of deprivation with the various (and more recent) Indices of Multiple Deprivation for the different nations shows that the two measures are highly correlated. This indicates that the 2001 Census data provides a reasonable comparative measure of deprivation across local authorities; furthermore it can be applied consistently across all local authorities in the UK.

The coverage in terms of level of deprivation (using the Social Grade D or E measure) is illustrated for all authorities in the UK in Figure 1. The black line indicates proportions of local authority populations of Social Grade D or E, and the vertical blue bars represent those local authorities contributing data on food waste in kerbside residual to the study. Figure 1 shows that coverage across the UK for this measure of deprivation is good.

[15] *At the time of writing, 2011 Census data on Social Grade by local authority was not available for Scotland and therefore the more recent 2011 Census data on deprivation levels could not be applied consistently across the UK.*

Figure 1: Coverage of local authorities performing compositional studies (levels of deprivation): UK



3.2 Coverage by region and nation

The coverage of the sampled local authorities by English region and UK nation are in Table 5. Coverage by English region is poor, with no data available for authorities in London and the North East. However, this is not a significant concern, as the amount of food waste produced per household in different regions was found to be similar (*Defra WR0119* project).

As shown in Table 9, there is limited coverage for Wales and Scotland (2 dataset for Wales and 4 datasets for Scotland) and no datasets for Northern Ireland. This means that the sample cannot be stratified by nation without giving disproportionate weight to those data points outside England. This also means that separate estimates cannot be produced for all UK nations. However, data from all nations with relevant information has been used to obtain UK estimates. The 2010 study found that there were no significant differences between the nations in food waste arisings per household.

Table 5: Breakdown of local authorities by English region and UK Nation – population and sample

Region / Nation	Population		Sample	
	No. LAs	% of LAs	No. LAs	% of sample
East Midlands	40	10.0%	11	17.5%
Eastern	46	11.5%	11	17.5%
London	33	8.3%	0	0.0%
North East	12	3.0%	0	0.0%
North West	39	9.8%	9	14.3%
South East	67	16.8%	9	14.3%
South West	32	8.0%	10	15.9%
West Midlands	30	7.5%	7	11.1%
Yorkshire & the Humber	21	5.3%	2	3.2%
England	320	80.0%	59	93.7%
Wales	22	5.5%	1	1.6%
Scotland	32	8.0%	3	4.8%
Northern Ireland	26	6.5%	0	0.0%
Total	**400**	**100.0%**	**63**	**100.0%**

3.3 Coverage by population density

An assessment of coverage by population density in UK authorities is presented in Table 6, which shows excellent coverage for the local authorities included in the sample, with only a slight under-representation of authorities in the top quartile for population densities for authorities in the UK.

Table 6: Coverage by local authority level population density in the United Kingdom

Quartile	Interquartile Range for UK LAs, (inhabitants / hectare)	No. sample LAs	Percentage of sample LAs
1	0.08 – 1.65	17	27.0%
2	1.66 – 5.03	17	27.0%
3	5.04 – 18.52	16	25.4%
4	18.53 – 148.83	13	20.6%

3.4 Coverage by collection system

The number of authorities targeting or not targeting food waste for collection is compared in Table 7 for the sample and the UK. There is slight over-representation of authorities with collections targeting food waste. As discussed in §2.5.2, this means that the sample is skewed towards local authorities which tend to have lower food waste arisings in kerbside residual, due to some food waste being diverted to collections targeting food waste. Therefore, the samples have been stratified to account for this effect in order to produce robust estimates.

Table 7: Coverage by food waste collection system

Food waste collection system	UK		Sample local authorities	
	No. LAs	% of LAs	No. LAs	% of sample
Collections targeting food waste	213	53.2%	27	56.3%
No collections targeting food waste	187	46.8%	36	43.7%
All local authorities	**400**	**100.0%**	**63**	**100.0%**

Coverage by kerbside residual collection frequency is shown in Table 8. This shows that the fortnightly kerbside residual collections are slightly over-represented in the sample.

Table 8: Coverage by kerbside residual collection frequency

Kerbside residual collection frequency	UK		Sample local authorities	
	No. LAs	% of LAs	No. LAs	% of sample
Weekly	146	36.5%	43	31.7%
Fortnightly	254	63.5%	20	68.3%
All local authorities	**400**	**100.0%**	**63**	**100.0%**

A comparison of average arisings of food waste at the kerbside (residual + collected for treatment) for the sample authorities in the 2012 "pooled" estimates suggests that food waste arisings are lower in areas with fortnightly residual collections:

- 184.2 kg / hh / yr in local authorities with weekly residual; and
- 160.7 kg / hh / yr in local authorities with fortnightly residual.

The sample is not stratified according to kerbside residual collection frequency as the impact on the results is relatively small (around 0.3% for the standard method). The issues relating to uncertainty in the estimates are discussed in detail in the *Methods Annex Report* (Chapter 13).

3.5 Coverage by period and season

Coverage of kerbside residual compositional studies by year is discussed in §2.3. Table 9 shows coverage for all compositional data for all waste streams included in the pooled estimates for 2012, apart from food waste collected for treatment which has been ascertained from analysis of WDF tonnages (see §2.5.5). Coverage outside England is poor, (as discussed in §3.2). The coverage in England for residual waste data is reasonable, though with some bias towards 2011. The number of kerbside dry and HWRC residual audits included are much lower, although this is not a significant concern, as the food waste arisings in these streams are much smaller than in the kerbside residual waste stream and food waste collected for treatment.

Table 9: Coverage by period during which waste compositional audits were carried out (for 2012 pooled estimates)

		2011	2012	2013	Total
England	Kerbside residual	41	29	6	**76**
	Kerbside dry recycling	10	4	0	**14**
	HWRC residual	11	1	0	**12**
Wales	Kerbside residual	2	0	0	**2**
	Kerbside dry recycling	0	0	0	**0**
	HWRC residual	0	0	0	**0**
Scotland	Kerbside residual	1	2	1	**4**
	Kerbside dry recycling	0	0	0	**0**
	HWRC residual	0	0	0	**0**
Northern Ireland	Kerbside residual	0	0	0	**0**
	Kerbside dry recycling	0	0	0	**0**
	HWRC residual	0	0	0	**0**

Table 10 shows the number of phases of auditing by season for the sample, relating to compositional data for kerbside residual included in this study. The seasons have been defined using the four reporting quarters for WDF, that are in line with the financial year, and are as follows:

- Quarter 1: April, May, June;
- Quarter 2: July, August, September;
- Quarter 3: October, November, December; and
- Quarter 4: January, February, March.

There is a bias towards audits carried out in January to March (Table 10). However, analyses of seasonal variations in food waste arisings have not produced consistent results, suggesting that seasonal variation is low; see Appendix 1.

The sample is not stratified according to seasonal coverage, given that levels of seasonality are low and because other factors in the coverage could be affecting the results as well, particularly residual collection frequency (see §2.5.2). It is considered that the compiled

dataset does not provide sufficient data points to allow stratification by seasonality (in addition to whether the local authority has collections targeting food waste).

Table 10: Seasonal coverage by number of phases of auditing for kerbside residual compositional data

	January to March	April to June	July to September	October to December
No. phases	43	9	10	20

4.0 Estimates for household food waste arisings collected by local authorities in the UK

Section 4.1 presents estimates of local authority collected household food waste arisings for the UK in 2012, consistent with the definition in §1.2. A comparison of food waste arisings in local authorities targeting and not targeting food waste for treatment is presented in §4.2. Data on food waste arisings in kerbside residual waste at the secondary category level (i.e. by types of food waste) are included in §4.3. Finally, an account of food waste in street sweepings and litter is presented in §4.4. Food waste arisings estimates across different periods can be found in Appendices 2 and 3. For a comparative analysis of food waste arisings over time, refer to the *Household Food and Drink Waste in the United Kingdom 2012* report.

Separate estimates for local authority collected household food waste cannot be produced for all the UK nations, due to insufficient kerbside residual compositional data for all nations (see §3.2).

4.1 Local authority collected household food waste arisings in the UK in 2012

Tonnage estimates for total local authority collected household food waste arisings for the UK in 2012 (pooled estimates) are shown in Table 11, with 95% confidence intervals included. The same data is shown in Table 12 in terms of kg per household per year.

Table 11: Estimated arising of local authority collected household food waste in the UK 2012, tonnes

Waste Stream	Food waste arisings	95% Confidence Interval*
Kerbside residual	4,036,540	±170,610
Kerbside collections targeting food waste	537,471	0**
Kerbside dry recycling (contamination)	43,812	±22,575
HWRC residual	55,011	±25,695
TOTAL	**4,672,835**	**±174,005**

*Confidence intervals include sampling errors, but do not include other uncertainties (*Methods Annex Report, Chapter 13*)

**Given that this information is derived from WasteDataFlow, there is no sampling error, but there will be other uncertainties associated with it, as discussed in the *Methods Annex Report, Chapter 13*.

Table 12: Estimated arising of local authority collected household food waste in the UK 2012, kg / hh / yr

Waste Stream	Food waste arisings	95% Confidence Interval*
Kerbside residual	150.9	±6.4
Kerbside collections targeting food waste	20.1	0**
Kerbside dry recycling (contamination)	1.6	±0.8
HWRC residual	2.1	±1.0
TOTAL	**174.7**	**±6.5**

*Confidence intervals include sampling errors, but do not include other uncertainties (refer to *Methods Annex Report*)

**Given that this information is derived from WasteDataFlow, there is no sampling error, but there will be other uncertainties associated with it, as discussed in the *Methods Annex Report, Chapter 13*.

4.2 Comparison of authorities with and without collections targeting food waste

A comparison has been made of food waste arisings in local authorities targeting or not targeting food waste at the kerbside for treatment. The waste streams considered were food waste in kerbside residual and food waste collected for treatment. The average arisings of food waste in each group of authorities has been found to be very similar, at 171 kg / hh / yr (±13 kg / hh / yr) for authorities not targeting food waste and 167 kg / hh / yr (±9 kg / hh / yr) for authorities targeting food waste[16]. Therefore, any food waste prevention effect from the provision of targeted collections for food waste is not detectable in the data collected for this study (i.e. the difference between these two figures is not significant at the 95% confidence level). This is consistent with recent analysis published by WRAP[17].

4.3 Secondary level composition of the food waste in kerbside collected residual waste

An analysis of food waste composition at the secondary level (i.e. for different types of food waste identified in waste audits) was carried out for compositional studies which audited kerbside collected residual waste, which is where the majority of food waste arises (§4.1). The collated compositional studies used a variety of categorisation systems for characterising the different types of food waste audited. Therefore, it was necessary to use simple sub-categories, in order to maximise the number of studies whose data on food waste sub-fractions could be harmonised. The sub-categories used in this analysis are:

- Home compostable and non-home compostable food waste;
- Avoidable food waste (i.e. edible food waste) and unavoidable food waste (i.e. inedible food waste, such as peelings, bones, etc.).

The results of this analysis are shown in Table 13. Far more data is available for the home compostable and non-home compostable sub-categories, with these sub-categories present in 67 of the collated studies. The analysis suggests that there are roughly equal arisings of home and non-home compostable food wastes.

[16] *These figures are for food waste in kerbside residual and kerbside collections targeting food waste (i.e. omitting food in dry recycling and HWRC residual). There is only data from sufficient local authorities to compare the two waste streams included.*

[17] *Effect of food waste collections on arisings: recent evidence (WRAP, 2013):* http://www.wrap.org.uk/sites/files/wrap/Effect%20of%20food%20waste%20collection%20on%20arisings%20WRAP%20UK_0.pdf

There are fewer studies splitting food waste into avoidable and unavoidable waste. This classification does not include a category of 'possibly avoidable' waste, so is difficult to compare with results presented in *Household Food and Drink Waste in the United Kingdom 2012*, which does include this category. However, the proportion of waste in local authority collected streams that is avoidable is similar (62% in Table 13, 55% for *Household Food and Drink Waste in the United Kingdom 2012*).

Table 13: Secondary level compositional assessment of food waste arisings in kerbside collected waste

	Home-compostable food waste	Non-home compostable food waste	Avoidable food waste	Unavoidable food waste
No. studies	92	92	11	11
Average	**46.0%**	**54.0%**	**62.4%**	**37.6%**
95% confidence interval	±2.5%	±2.5%	±6.6%	±6.6%

4.4 Food waste arising in street sweepings and litter

It is not possible to distinguish between street sweepings and litter in WDF, with both types of waste reported under a "Street cleaning" category. Therefore, estimates of food waste arisings presented here, and in the previous 2010 study, have produced a single figure for street sweepings and litter combined.

The 2010 study provided an estimate of food waste arising in street sweepings and litter[18], with 10.7% of street sweepings and litter estimated to consist of food waste. This previous estimate was based largely on data collated for the 2006/07 compositional estimates[19]. A small amount of additional data on the composition of street sweepings and litter was collated for the current project. Only more recent compositional data from the previous study (2009 onwards) is included. This indicates an estimated arising of food waste in street sweepings and litter of 11.2%, derived from 18 datasets.

Table **14** shows estimated total arisings of street sweepings during 2012, and estimated arisings of food waste in these streams. These estimates are substantially lower than for the 2010 study (which estimated 101,000 tonnes of food waste in street sweepings and litter in England). However, this decrease could be due to reporting issues in WDF, as in the 2012 WDF data some authorities did not report any tonnages under "Street cleaning".

Table 14: Estimated UK arisings food waste in street sweepings and litter 2012 (tonnes)

	England	UK
All street sweepings and litter	683,135	815,790
Food waste in street sweepings and litter	76,263	91,072

[18] *Synthesis of Food Waste Compositional Data 2010, WRAP and Resource Futures, 2011, p 19.*

[19] *Defra WR0119, Municipal Waste Composition: Review of Municipal Waste Component Analyses.*

Appendix 1: Analysis of seasonal variations in food waste arisings

The 2010 study[20] carried out an analysis of seasonal variation in food waste arisings in kerbside residual for data used in the England 2006/07 waste compositional estimates[21]. The analysis and results in this appendix provide additional information on the seasonal variations in food waste arisings collected by local authorities. In particular, this analysis uses data from 2008 to 2012 and includes both the kerbside residual stream and kerbside collections targeting food waste.

Multi-phase audits were split into their constituent phases. Audit data from single-phase audits were also included. In total 170 phases of kerbside residual audit data were collated in this way. The waste audits were carried out from 2008 to 2012. Each waste audit data point was aligned with WDF kerbside residual tonnages for the relevant quarter, relating to when the study was carried out. The 'seasons' were therefore defined in terms of the quarters in which WDF is reported, which relates to the financial year[22]. The resulting quarters are:

- January to March;
- April to June;
- July to September; and
- October to December.

Table 15: Seasonal variation in food waste arisings in kerbside residual waste and collections targeting food waste (data from 2008 to 2012)

	January to March	April to June	July to September	October to December
No. of phases	55	36	41	35
Mean arisings (kg / hh / yr)	166.9	166.1	183.8	180.3
95% confidence interval (kg / hh / yr)	±11.3	±9.7	±11.8	±9.5

Average arisings of food waste in kerbside collected waste in terms of kg / household / year are shown in Table 15 and Figure 2, with 95% confidence intervals included in Table 15, and represented by the error bars in Figure 2. This suggests that arisings in the first half of the year might be lower than the second half of the year.

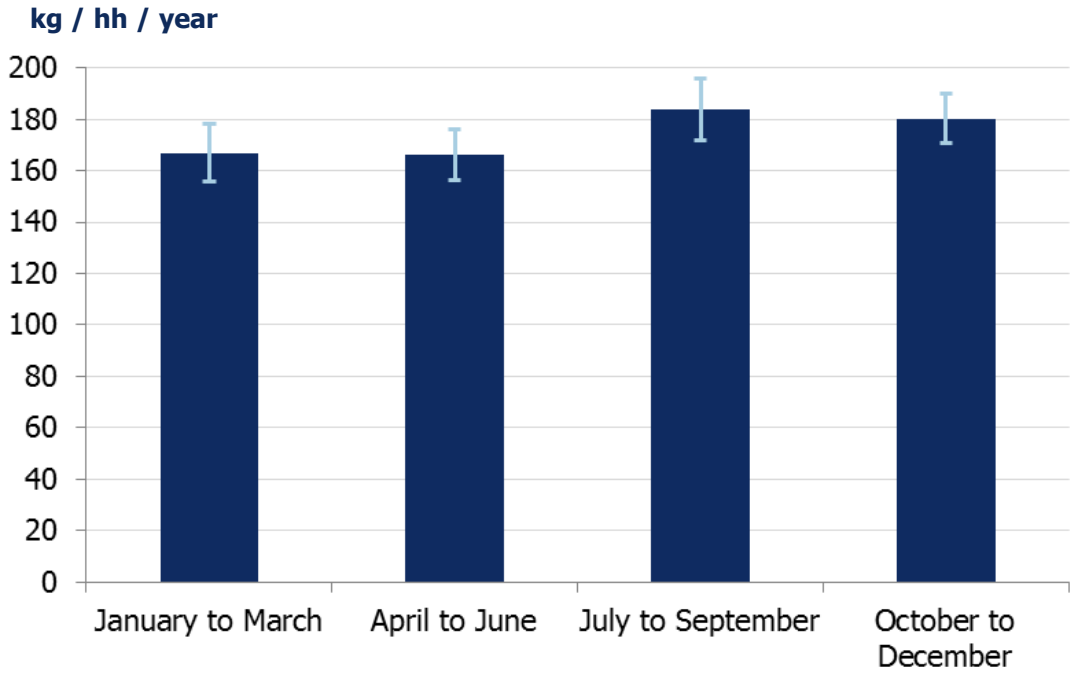
A one-way ANOVA test was performed to determine the probability that the amount of food and drink waste for each study was drawn from the same sample. For data represented in Table 15, the *p*-value was 0.056. This suggests that there is some evidence that food waste arisings differ between seasons (i.e. lower in the first half of the year), although this evidence falls short – just – of the 5% significance level frequently applied as a threshold to statistical significance.

[20] *Synthesis of Food Waste Compositional Data 2010, WRAP and Resource Futures, 2011 (Appendix 1).*

[21] *Defra WR0119, Municipal Waste Composition: Review of Municipal Waste Component Analyses, Resource Futures, 2009.*

[22] *This differs from the 2010 study, which used quarters starting in March, June, September and December.*

Figure 2: Seasonal variation in food waste arisings in kerbside residual waste and collections targeting food waste (data from 2008 to 2012) – all studies



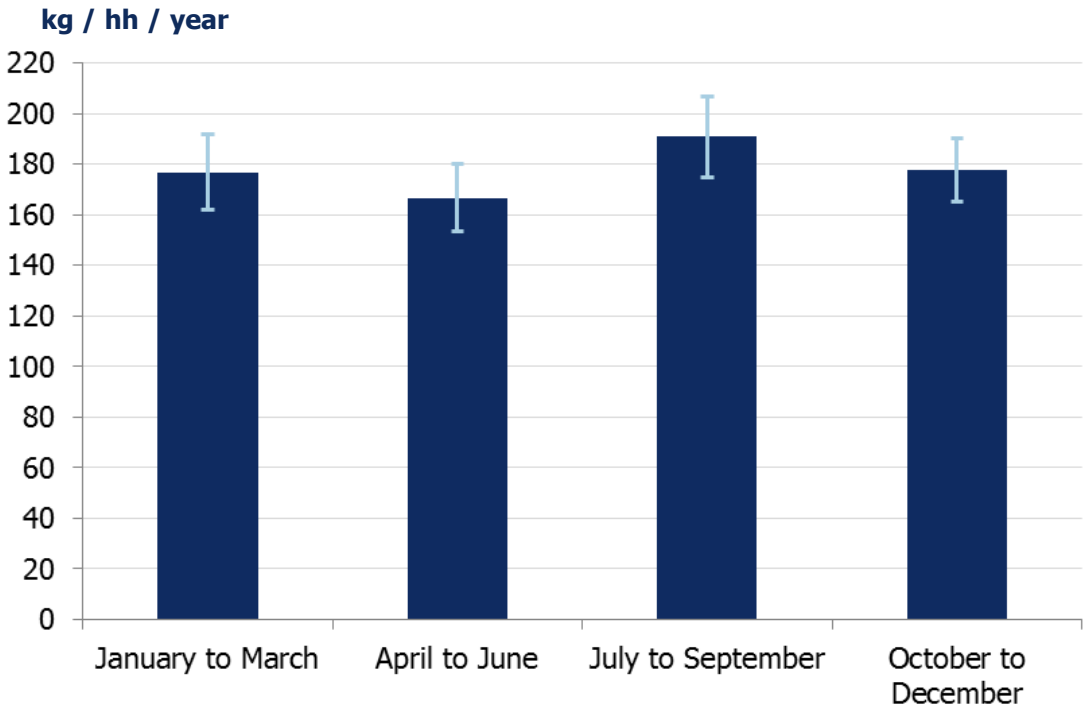
However, estimating the proportion of food waste in mixed garden and food waste collections is problematic, particular in a seasonal analysis where the garden waste portion exhibits fluctuations, which are far greater than would be expected with food waste. Therefore, the analysis was repeated with the removal of all studies where any food waste had been collected for treatment as part of mixed garden and food waste collections (Table 16 and Figure 3).

Table 16: Seasonal variation in food waste arisings in kerbside residual waste and collections targeting food waste (data from 2008 to 2012) – data from authorities targeting food waste in mixed organics collections excluded

	January to March	April to June	July to September	October to December
Mean arisings (kg / hh / yr)	176.8	166.7	190.9	177.8
No. of phases	28	18	18	23
95% confidence interval (kg / hh / yr)	±15.1	±13.2	±16.1	±12.5

A one-way ANOVA test was also performed to determine the probability that the amount of food and drink waste for each study was drawn from the same sample. This gave a *p*-value of 0.23, which suggests that there is insufficient evidence to conclude that the data was drawn from different distributions. This means that seasonal variation in the amount of waste generated are not statistically significant.

Figure 3: Seasonal variation in food waste arisings in kerbside residual waste and collections targeting food waste (data from 2008 to 2012) – data from authorities targeting food waste in mixed organics collections excluded

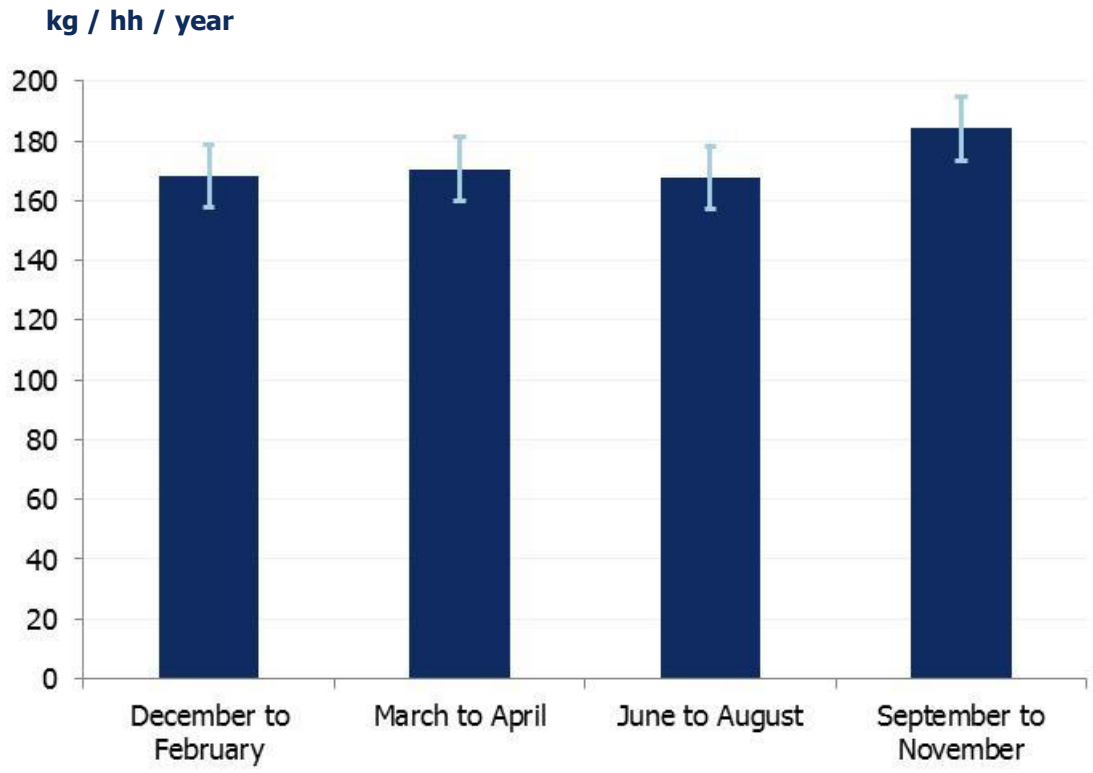


The above findings are at slight variance with the analysis of seasonal variation carried out for the 2010 study[23] (which used data from 2005 to 2007), which found slightly higher arisings during autumn: September to November; see Figure 4. This data only analysed food waste arisings in kerbside collected waste, although very little food waste was collected for treatment during the period covered by the analysis.

The evidence on seasonal variations in food waste arisings is therefore inconclusive, but any variations that are indicated in the data appear to be fairly limited in extent. For further discussion on potential seasonal variations in food waste and how these might affect the food waste arisings estimates, refer to the *Methods Annex Report.*

[23] *Synthesis of Food Waste Compositional Data 2010, WRAP and Resource Futures, 2011, pp 21-22.*

Figure 4: Seasonal variation in food waste arisings in kerbside collected waste (data from 2005 to 2007). Data from all local authorities.



Appendix 2: "Pooled" estimates for 2009

A separate set of estimates was produced around a baseline period of the calendar year 2009, which used WDF tonnages for the calendar year 2009 and waste compositional studies from 2008 to 2010. These are referred to as "pooled" estimates (§1.1). The same approach as used for the 2010 and 2012 pooled estimates was applied, as described in Chapter 2.0.

Table 17: The coverage of compositional datasets by year and nation.

Number of datasets by year	
2008	16
2009	47
2010	45
Number of datasets by nation	
England	74
Wales	22
Scotland	12
Northern Ireland	0

Tonnage estimates for total local authority collected household food waste arisings for the UK in 2009 are shown in Table 18, with 95% confidence intervals included. The same information is shown in Table 19 in terms of kg / household / year.

Table 18: Estimated arising of local authority collected household food waste in the UK 2009, tonnes

Waste Stream	Food waste arisings	95% Confidence Interval*
Kerbside residual	4,552,965	±138,478
Kerbside collections targeting food waste	217,029	0**
Kerbside dry recycling (contamination)	56,342	±11,507
HWRC residual	89,321	±25,912
TOTAL	**4,915,656**	**±141,351**

*Confidence intervals include sampling errors, but do not include other uncertainties (refer to *Methods Annex Report*)

**Given that this information is derived from WasteDataFlow, there is no sampling error, but there will be other uncertainties associated with it, as discussed in the *Methods Annex Report*.

Table 19: Estimated arising of local authority collected household food waste in the UK 2009, kg / household / yr

Waste Stream	Food waste arisings	95% Confidence Interval*
Kerbside residual	174.5	±5.3
Kerbside collections targeting food waste	8.3	0**
Kerbside dry recycling (contamination)	2.2	±0.4
HWRC residual	3.4	±1.0
TOTAL	**188.4**	**±5.4**

*Confidence intervals include sampling errors, but do not include other uncertainties (refer to *Methods Annex Report*)

**Given that this information is derived from WasteDataFlow, there is no sampling error, but there will be other uncertainties associated with it, as discussed in the *Methods Annex Report*.

Appendix 3: Other calculation methods for producing estimates

The local authority collected household food waste arisings estimates produced for the 2012 pooled[24] estimates in the UK and presented in Chapter 4.0 use the "standard" methodology for calculations, described in §2.5.1. An "alternative" methodology for calculating estimates is described in §2.5.3. This also applies to the 2009 pooled estimate presented in *Appendix 2: "Pooled" estimates for 2009*.

Additionally, "single-year" estimates have been produced for each calendar year from 2006 to 2012, for both the UK and England (insufficient information was available to produce estimates for the other nations in the UK). The single-year estimates have only used compositional data that relates to the relevant period (i.e. only 2008 compositional data used for the 2008 single-year estimate), whereas the pooled estimates have included some data outside the baseline period (i.e. the 2009 pooled estimate included data from 2008 to 2010). Coverage for the single-year estimates is summarised in §2.3. The calendar year estimates have been calculated using both the standard and alternative methodology.

The total arisings estimated for the UK using these different methods, and for different periods are shown in Figure 5 in tonnes, with 95% confidence intervals indicated for the single-year estimates calculated using the standard methodology. The same data is shown in terms of kg / hh / yr in Figure 6. The data presented cover only the kerbside residual and kerbside collections targeting food waste, as there is sufficient data to make comparisons over time; food waste in HWRC residual and kerbside dry recycling streams is omitted. As the coverage analysis of the single-year estimates shows (§2.3), there is a strong bias towards 2009 for Wales and Scotland studies. Therefore, an England version only of this comparative analysis is shown in Figure 7 and Figure 8.

The various estimates for each period agree well with one another. In particular, the pooled estimates for the standard and alternative methodologies are similar (Table 20), and are also similar to the relevant single-year estimates. This data shows a large decrease in food waste between 2007 and 2009, followed by a period of slower reduction between 2009 and 2012[25]. A range of factors, including the work of WRAP and its partners, increasing food prices and economic conditions will have played a role in bringing about this reduction in food waste, but determining the extent to which each of the various factors have played a role is extremely challenging. Research is being undertaken to understand the contribution of these elements, the reasons for the slowing down in the rate of reduction in recent years and steps that can be taken to address this.

Table 20: Comparison of standard and alternative methods for pooled estimates for 2012 (tonnes)

Waste stream	Standard	Alternative
Kerbside residual	4,036,540	3,968,195
Kerbside collections targeting food waste	537,471	537,471
Total of above	**4,574,012 ±170,610**	**4,505,666 ±199,019**

*Confidence intervals include sampling errors, but do not include other uncertainties (refer to *Methods Annex Report*)

[24] *See §1.1 for a definition of "pooled" estimates.*

[25] *For a discussion on changes in UK food waste from 2007 to 2012, please refer to the Household Food and Drink Waste in the United Kingdom 2012.*

Figure 5: Comparison of food waste arisings estimates for kerbside residual and kerbside collections targeting food waste – UK, millions of tonnes (95% confidence intervals for the single-year standard estimate)

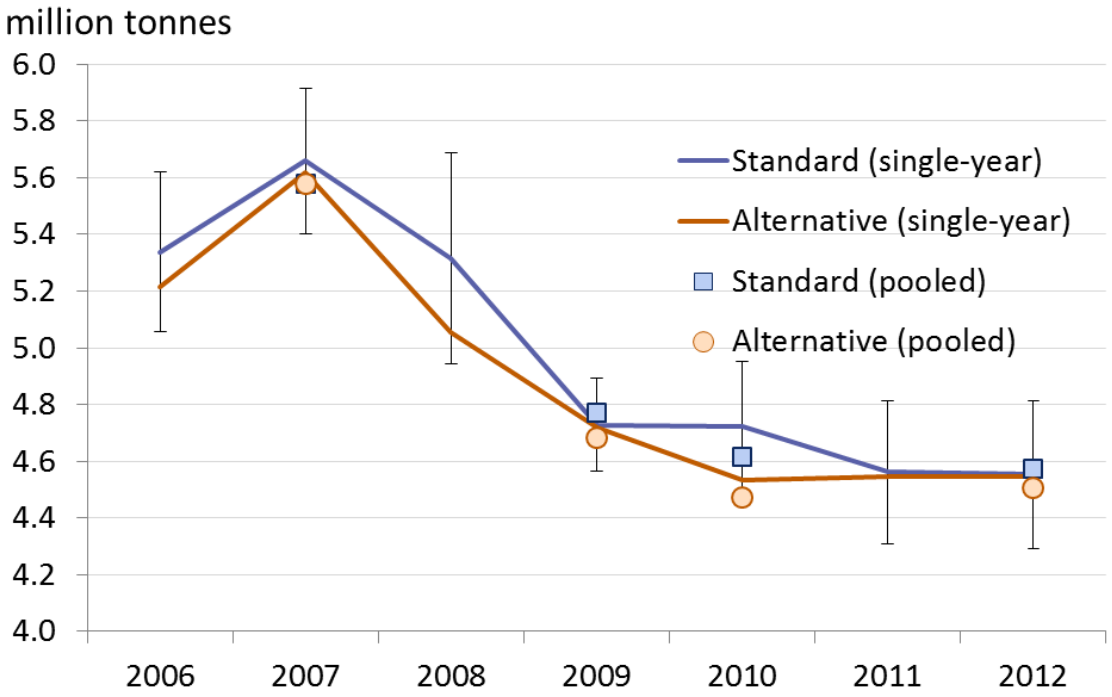


Figure 6: Comparison of food waste arisings estimates for kerbside residual and kerbside collections targeting food waste – UK, kg / hh / yr (95% confidence intervals for the single-year standard estimate)

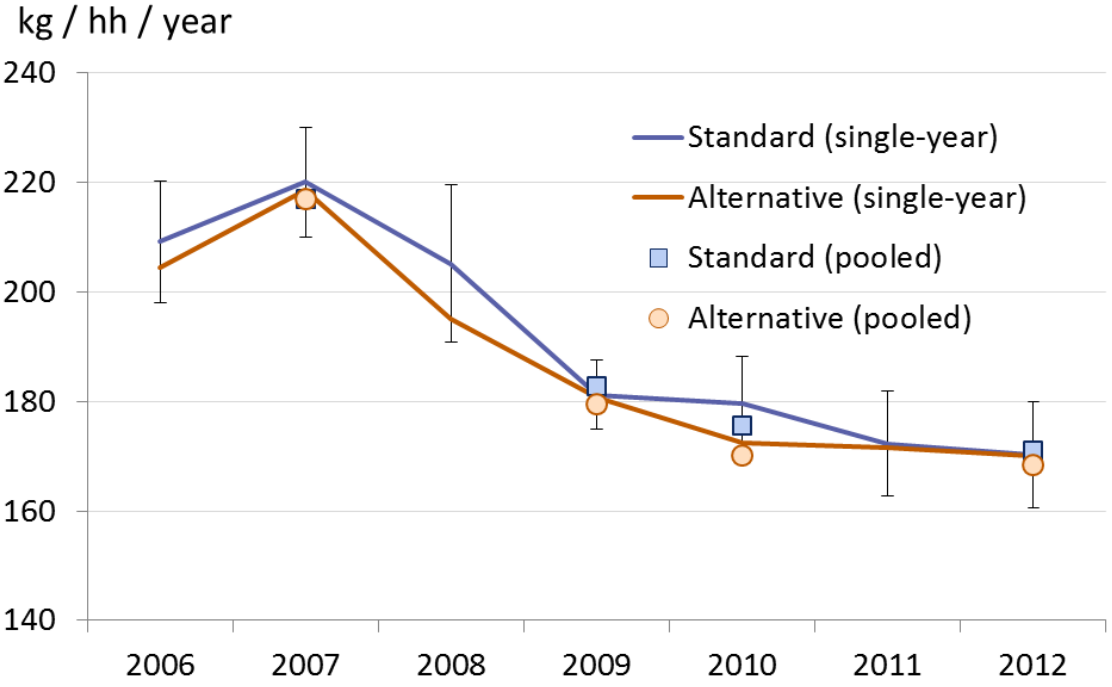


Figure 7: Comparison of food waste arisings estimates for kerbside residual and kerbside collections targeting food waste – England, millions of tonnes (95% confidence intervals for the single-year standard estimate)

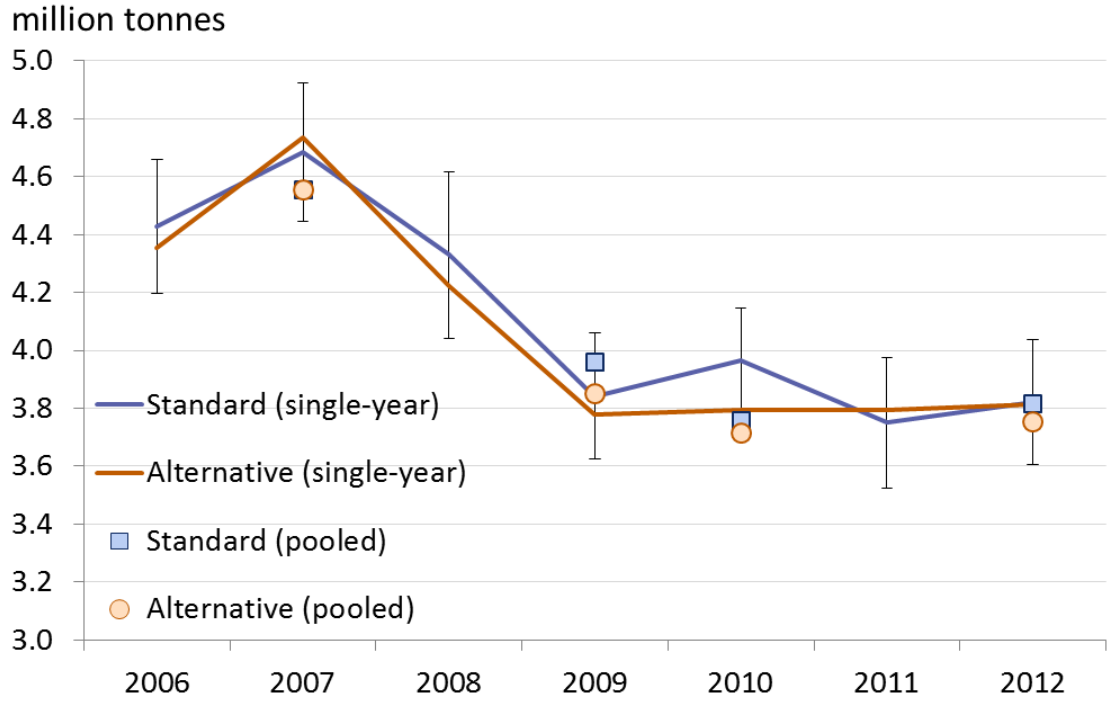
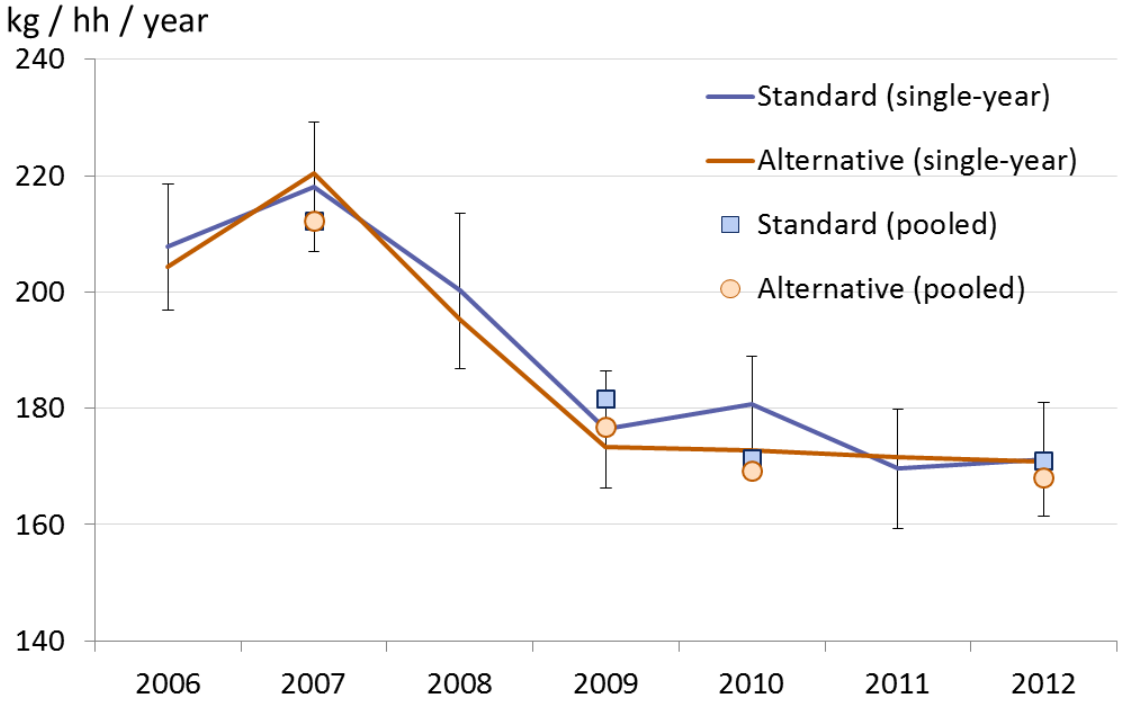


Figure 8: Comparison of food waste arisings estimates for kerbside residual and kerbside collections targeting food waste – England, kg / hh/ yr (95% confidence intervals for the single-year standard estimate)



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