Material change for a better environment

An assessment of the arisings of household collected food waste in the UK

Synthesis of Food Waste Compositional Data 2010

An analysis of compositional data and WasteDataFlow information to produce estimates of food in local authority collected waste streams from UK homes in 2010. A comparison is made with 2006/07 estimates for England.

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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 using the most recent data available. This work is of key importance to WRAP, its partners and its funders in terms of assessing whether the level of food waste has changed in recent years. The information in this report feeds into a broader assessment of recent changes in household food waste in the UK[2].

Method

Data from waste composition studies carried out between 2009 to 2011 have been collated and analysed alongside the most recently available WasteDataFlow tonnages, in order to arrive at estimates of LA-collected household food waste levels in the UK, incorporating data from each of the four nations within the UK. The updated estimate for England has been compared with a previous estimate relating to 2006/07 (financial year) to assess the degree to which LA-collected household food waste arisings may have reduced in England. There are no comparable estimates at nation level for Scotland, Northern Ireland or Wales. Data for these three nations are not individually presented in this report.

For the purposes of this project, LA-collected household food waste has been assumed to include food in:

- kerbside refuse;
- kerbside dry recycling (as contamination);
- kerbside food-waste and mixed-organics collections; and
- household waste recycling centre (HWRC) residual waste.

Data on food waste arisings in kerbside refuse – the most important waste stream to consider for this project – were obtained for 89 local authorities across the UK. The LAs with compositional studies were reasonably representative of the UK in terms of deprivation levels; the sample was stratified by food-waste collection system to account for differences between the sample and the population. Compositional data are particularly problematic for Northern Ireland, where the only data available are from a study carried out in 2007.

Results

Total household LA-collected food waste arisings for the UK, in 2010, were 4,620,000 tonnes per year (± 160,000 tonnes), or 172 kg/hh/yr (±7)[3]. There were no significant differences between the UK nations in the level of food waste per household (§4.1).

The amount of food waste collected by LAs **in England** has decreased, from 4,650,000 tonnes in 2006/07 to 3,820,000 tonnes in 2010, i.e. by around 840,000 tonnes (± 210,000 tonnes) – a reduction of 18%. This reduction has occurred against a backdrop of growth in household numbers: 4.2% between 2006/07 and 2010. The amount of food waste **per household per year** has reduced by 46 kg/hh/yr (or 21%) over the same time period. There are no previous studies allowing similar comparison over time in Wales, Scotland or Northern Ireland.

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

[2] New estimates for household food and drink waste in the UK, www.wrap.org.uk/hhfwfacts

[3] 95% confidence intervals are quoted – see Appendix 4 for more details on uncertainty. All estimates are to 3 significant figures.

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1.0 Introduction

The aim of this project is to produce estimates of food waste[4] collected by local authorities (LAs) from UK homes using the most recent data available. This work is of key importance to WRAP in assessing how the level of food waste has changed in recent years.

Over the course of its 2008-11 business plan, WRAP has run a Household Food Waste Prevention programme, aimed at reducing the quantity and environmental impact of household food waste across the UK, working in partnership with a wide range of organisations, including LAs, Courtauld Comittment signatories and community groups. It is therefore necessary for the quantities of household food waste produced in the UK to be ascertained; to track progress against targets to report to WRAP's funders, and to understand the impact of work to date. The information in this report feeds into a broader assessment of recent changes in household food waste in the UK, including other routes for discarding food waste and losses (home composting, fed to animals and the kitchen sink) alongside other contextual data[5].

Data from waste composition studies carried out since the Defra project WR0119: *Review of Municipal Waste Component Analyses* (§1.2) have been collated and analysed alongside the most recently available WasteDataFlow tonnages, in order to arrive at assessments of the arisings of LA-collected household food waste for the UK in 2010. The updated estimate for England has been compared with a previous estimate relating to 2006/07 (financial year) to assess whether the level of LA-collected household food waste has changed in England. There are no previous studies allowing similar comparison over time in Wales, Scotland or Northern Ireland.

1.1 Definitions

1.1.1 Definition of local authority collected household food waste

The focus of this study is on household food waste collected by local authorities, consisting of food waste which is likely to have been generated from within the household (i.e. purchased, taken home and then part or all of it disposed of as food waste), and is assumed to include food waste found in kerbside and household waste recycling centre (HWRC) streams. There are some data on food waste in other municipal waste streams, such as street sweepings and litter (§ 4.6). Although some of these streams are classified as part of household waste within WasteDataFlow, food waste arisings from these sources have not been included in the estimates presented in this report as the food waste found in these streams is less likely to have come from households.

More specifically, for the purposes of this study LA-collected household food waste is classified as that found within the following streams:

- **Household residual bin** (i.e. kerbside collected household refuse).
- **Household food waste collections** (specifically separate food waste collections, from households at the kerbside).
- **Household organic collections accepting food waste** (specifically mixed organic collections where food waste is amongst the target materials, from households at the kerbside).
- **HWRC residual waste.**

It was found that no collections of food waste 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.

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

[5] *New estimates for household food and drink waste in the UK;* www.wrap.org.uk/hhfwfacts

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. slices of bread, apples, meat).
- **Possibly avoidable**: food and drink that some people eat and others do not (e.g. bread crusts), or that can be eaten when a food is prepared in one way but not in another (e.g. 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)[6].

Only a small number of studies differentiated between these types of waste and these results are reported in §4.1.1.

1.1.2 Definition of food waste collected for treatment

An increasing quantity of food waste is collected at the kerbside, either separately or as part of mixed organic collections (garden waste and food waste, sometimes with cardboard). This collected material is diverted from disposal (landfill or energy from waste), the treatment often consisting of composting, although a growing fraction of this material is sent to anaerobic digestion or other treatment methods. For the purposes of brevity, this material is hereafter referred to as "food waste collected for treatment".

1.2 The previous England estimate – Defra WR0119 study

An estimate of LA-collected household food waste arisings in England in 2006/07 (financial year) was determined within the Defra project: WR0119 *Review of Municipal Waste Component Analyses*[7] (hereafter referred to as WR0119), carried out by Resource Futures. For WR0119, a large number of audit studies of kerbside waste were collated. Selection criteria were applied to these studies, which were essentially the following:

- Studies to have been carried out no earlier than 2005.
- Multi-phase studies only, where seasonality had been controlled for to some extent.
- Samples had been stratified by the type of area or household (usually via the ACORN classification system) to reflect the profile of the local authority where the study took place.

These data were analysed alongside 2006/07 WasteDataFlow tonnages for residual and recycling, in order to build total kerbside composition profiles for local authorities where residual waste audit data were available. These then formed the basis for calculating national estimates of waste composition. For kerbside residual waste, waste audit data were included for 120 local authorities for the WR0119 project. This provided good coverage of England, particularly in respect to socio-economic gradient.

Comparison is made in the current report between the estimates from WR0119 and those for 2010 (§4.2).

[6] *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

[7] http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15133

2.0 Methodology

2.1 Collation of kerbside waste audit studies

A major part of this project involved collating waste audit studies carried out since the WR0119 project (see §1.2). This involved collating and organising studies carried out by Resource Futures and obtaining studies carried out by other contractors. Studies by other contractors were identified through investigating records of tender invitations for waste compositional work (which Resource Futures had not been successful in winning) and requests direct to local authorities via the LARAC and Resource Recovery Forum networks. The Caledonian Environment Centre organised compositional datasets that they already held, and contacted local authorities in Scotland to obtain any additional compositional studies that had been carried out.

2.2 Selection criteria for inclusion

In common with the previous work, producing national waste arisings estimates in England (WR0119, see §1.2), selection criteria were developed to ensure that the waste compositional studies collated were sufficiently robust to be used to build updated food waste arisings estimates. The key criteria for kerbside studies were:

- Studies to have been carried out from 2009 onwards.
- Samples had been stratified by area type at the district level (mostly by ACORN category, though by Council Tax Band in a few instances), to reflect the socio-demographic profile of the local authority where the study took place.

Many of the collated studies had been carried out over only a single phase. In the previous WR0119 study (§1.2), one of the selection criteria was that the studies should be multi-phase, in order to control for seasonality. However this selection criterion was not applied for the current study, as food waste is one of the fractions of household waste that is least susceptible to seasonal variations (Appendix 1), compared with other fractions that exhibit pronounced seasonality, such as garden waste and various packaging materials. This has the advantage of increasing the number of studies available for analysis.

The first criterion (that studies should have been carried out since 2009) could not be applied for Northern Ireland, as the only compositional studies available were carried out in 2007 (§2.3.1). Therefore compositional data from 2007 have been used for Northern Ireland.

Data for one authority in England and one authority in Wales were excluded as outliers, as the kerbside datasets had an unrealistic values for food waste arisings, in each case being over three standard deviations above or below the mean value for food waste arisings at the kerbside in, respectively, England and Wales.

For audits of HWRC residual waste, two key selection criteria were applied:

- Studies to have been carried out since the WR0119 project.
- Black bag waste analysed (as this can be expected to contain the majority of food waste in HWRC residual waste).

2.3 Analysis of WasteDataFlow tonnages

WasteDataFlow tonnages were obtained for all local authorities in the United Kingdom. Kerbside refuse and recycling and HWRC residual tonnages were extracted for all local authorities. WasteDataFlow recycling tonnages were analysed in order to estimate tonnages of food waste collected for treatment (as well as quantifying kerbside dry recycling arisings, to enable the calculation of estimates for the relatively small quantities of food waste found as contaminants in some kerbside dry recycling collections).

2.3.1 WasteDataFlow and baseline periods for estimates

The aim of this study is to produce estimates of national household food waste arisings that are as current as possible. Therefore WasteDataFlow tonnages were obtained for the latest four quarters (i.e. 12 month period) available at the time of the study. This period relates to October 2009 to September 2010, which for the purposes of this project has been considered to refer to the calendar year 2010. The compositional data for England fit reasonably well for this period. Scotland compositional data fit less well, with more studies carried out during 2009, but with some 2010 studies also included (§3.4, Table 3.4).

WasteDataFlow tonnages were also obtained for the financial year 2009/10 for all UK authorities. However, in Wales all compositional data relating to residual waste were from 2009. Given that many Welsh authorities have introduced or rolled out food waste collections between 2009 and 2010, this means that combining 2009 compositional data for kerbside refuse with 2010 WasteDataFlow tonnages would be likely to result in an overestimate of food waste in the residual stream (given the diversion of food waste away from residual waste stream between 2009 and 2010). Therefore, total food waste arisings in kerbside (both in refuse and collected for treatment) were calculated for Wales using 2009/10 WasteDataFlow tonnages and 2009 compositional data. The split of this total into food waste in refuse and collected for treatment was determined by referring to WasteDataFlow data for 2010.

A similar problem arises for Northern Ireland, where the only compositional data available relate to the period 2007. WasteDataFlow tonnages for 2010 show some food waste being collected for treatment in Northern Ireland, whereas we would expect very little food waste to have been targeted in 2007. Therefore, total food waste arisings at the kerbside for Northern Ireland have been estimated on the basis of compositional data for kerbside refuse, and the amount separately collected for treatment in 2010 has been subtracted from this amount to arrive at a net figure for food waste in kerbside refuse.

Furthermore, HWRC residual data for Northern Ireland showed unrealistically high arisings of food waste (around 17%, c.f. around 3-6% for rest of the UK) and separate data were not available for the different authorities in Northern Ireland where HWRC residual waste had been analysed. Therefore, the average arising of food waste found in HWRC refuse elsewhere in the UK has been applied for Northern Ireland's HWRCs.

Coverage of compositional studies by period is summarised in §3.4.

2.3.2 Assessment of food waste arising in kerbside collections for treatment

WasteDataFlow includes a number of categories for organic waste collected at the kerbside for treatment. These tonnages were analysed to produce estimates for food waste collected for treatment for all UK authorities, wherever food waste is targeted. The following WasteDataFlow categories were relevant:

- **Waste food only:** this category is straightforward in that it includes only food waste, 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 WasteDataFlow 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. 57 local authorities reported tonnages in this category. For each of these instances the website of the local authority was investigated or the local authority was contacted by telephone, to determine the type of kerbside organics collection service in place, and thus estimate the likely composition of this material.

For mixed garden and food waste, where separate audit data were available for kerbside organics (from the collated waste compositional data) the proportion of food waste was determined with reference to the audit data for that authority. However, these data were only available for a few authorities and it was necessary to make a generic assumption for the other authorities with such collections. These assumptions were based on audits of mixed kerbside organics collections collated during the WR0119 review and the WRAP report *Performance analysis of mixed food and garden schemes*[8]. The WRAP study found that food waste arisings in weekly mixed food and garden collections were significantly higher than in fortnightly collections. Therefore separate assumptions were applied on the basis of kerbside organics collection frequency, with the proportion of food in mixed food and garden waste assumed to be:

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

The collection frequency for mixed organics collections have been determined from data from an audit of local authority collection schemes carried out by WRAP in November 2010. Where no information on collection frequency was available (which is the case for four local authorities), it has been assumed that collections are

[8] http://www.wrap.org.uk/downloads/Food_Garden_Waste_Report_Final.4df9a00c.8564.pdf

weekly. This assumption has been applied in order to arrive at a conservative estimate of the reduction in LA-collected household food waste arisings in England between 2006/07 and 2010. The assumptions for food waste arisings in mixed organics are the subject of a sensitivity analysis (§2.7 and §4.3). There is not sufficient information on seasonal differences of food waste in mixed organic collections to estimate the impact of seasonality.

2.4 Stratification of the sample

The degree to which the collated studies are representative of local authorities nationally – presented in §3 – was assessed in terms of:

- levels of deprivation;
- region; and
- collection system, in particular the degree to which authorities targeting food waste at the kerbside for treatment are represented.

The local authorities included in this study were found to provide reasonable coverage in respect to levels of deprivation (§3.1). Regional coverage was less good, though this was not considered to be a significant issue for this study, as was also the case in the previous assessment carried out for the 2006/07 estimates (§3.2).

However, in terms of collection systems, local authorities collecting food waste for treatment (in separate food waste collections or mixed organic collections) were significantly over-represented in the studies collated for English kerbside refuse (§3.3). To account for this in the analysis, the sample and population were stratified by presence of food waste collections.

Several approaches to stratifying the samples in terms of collection system where tested. It was found that the most robust approach was to place local authorities into two strata according to whether local authorities collect food waste at the kerbside, either in separate food waste or mixed organics collections. Each strata contained reasonable numbers of authorities and, furthermore, there was a large difference in the amount (per household) of food waste in the residual waste between these two strata. For example, for English local authorities in the sample with collections of food waste for treatment, there was on average 27% food waste in the residual stream (or 120 kg / household / year); for those English authorities **not** collecting food waste for treatment, the corresponding figures were 33% and 176 kg / household / year.

This stratification methodology was applied separately for England, Wales and Scotland. However the scarcity of compositional data available for Northern Ireland meant that the data for food waste in kerbside refuse in Northern Ireland could not be stratified in this manner.

One of the key factors that made accounting for food waste collections important was the methodology used for grossing up food waste arising estimates from data for the sample local authorities, described in §2.6. The targeting of food waste for treatment will result in the diversion of some food waste from kerbside refuse. Failing to make the sample representative of the proportion of authorities targeting food waste would result in errors in the estimates as this diversion would not be accounted for properly.

In addition to this diversion effect, there is the potential for food waste collections to affect the total quantity of food waste generated (e.g. a prevention effect). However, the direct evidence for this effect is limited[9], and there is considerable uncertainty about its magnitude and what factors influence it (e.g. frequency of refuse collections).

The important point for the current study is that the stratification methodology removes most distortions in the estimates emanating from over-representation in the sample of local authorities targeting food waste for treatment.

It should be noted that the compositional estimates for WR0119 (§1.2) for England in 2006/07 were based on unstratified samples. With respect to food waste, stratification would not have altered the results of WR0119 substantially, since very few authorities in England were collecting food waste for treatment at the kerbside at that time.The effects of various factors on food waste arisings, including collection systems, are further discussed in §4.5.

[9] http://www.wrap.org.uk/downloads/Impact_of_collection_on_prevention_FINAL_v2_17_8_11.eb133bfa.11159.pdf

2.5 Grossing up method for producing national estimates

The same grossing up method as used in the previous estimates (the WR0119 study, see §1.2) has been applied for this project. This consists of the following stages:

- **Kerbside refuse:** the weight of food waste is determined by taking each authoritiy in the sample (i.e. with compositional analysis data) and multiplying the total weight of kerbside refuse from WasteDataFlow by the proportion of food waste in kerbside refuse from the compositional data. This gives a proportion of food waste in the residual kerbside stream within the sample and this is scaled up to all residual waste in the population. This procedure is conducted for each of the two strata, i.e. once for all authorities collecting food waste for treatment and once for all other authorities.
- **Kerbside dry recycling:** a similar procedure to kerbside refuse is carried out for kerbside dry recycling: where compositional data identifies food waste contamination in kerbside dry recycling, this is used to arrive at an estimate of *national arisings of food waste in kerbside dry recycling.*
- **Kerbside organics collections**: the total food waste arising across all local authorities nationally is estimated from WasteDataFlow tonnages, as described in §2.3.2, to arrive at an estimate of *national arisings of food waste in kerbside organics collections.*
- **HWRC residual:** a similar procedure as for kerbside refuse and kerbside dry recycling is applied to arrive at an estimate of *national arisings of food waste in HWRC residual*.

The sum of food waste arisings across these four household waste streams is then calculated to arrive at a tonnage estimate of *national arisings of LA-collected household food waste.*

2.6 Standardising household counts

It is useful to express national tonnages of food waste in terms of kg per household per year. There are different methods and data sources for household counts and, therefore, care has been taken to apply household counts across all local authorities, nations and periods which are mutually comparable. For further information on the household counts used in this study refer to Appendix 2.

2.7 Sensitivity analyses

Sensitivity analyses have been carried out to assess the impact of factors around which there is a degree of uncertainity, but for which confidence intervals cannot be constructed. These include:

- The proportion of food waste in mixed organics (§4.3.1).
- Influence of including or excluding 'outlier' authorities (§4.3.2).
- An alternative grossing up method (Appendix 3).

2.8 Impact of alternative methods

Obtaining estimates of LA-collected household food waste is complicated and there are many potential methods for scaling compositional data with information from WasteDataFlow. To determine the approximate impact of the method employed, an alternative grossing up methodology was also used, which is described in Appendix 3.

The main difference for the alternative method is to determine the total arisings of LA-collected household food waste from **all** revelant waste streams before investigating the average of (and variation between) different local authorities. In contrast, the standard method determines the amount of food waste in the residual waste stream first, before adding in the food waste in other relevant waste streams.

The UK result is similar, though not identical, for the two methods; the picture for individual nations is slightly more variable (see Appendix 3 for discussion of the alternative method). The advantages of the 'standard' methodology used in this project are that it is consistent with the WR0119 project, the results are weighted by the amount of waste produced by an authority and the total waste figures are consistent with WasteDataFlow. Given the similarity in results with the standard method for the UK, this indicates that the results are not sensitive to detailed differences in the methodology.

3.0 Coverage assessment

Coverage assessments were carried out in respect of levels of deprivation (§3.1), region and nation (§3.2), and collection system (§3.3) to assess the degree to which the local authorities represented in the study data are representative of local authorities nationally. The assessment focuses on the coverage of studies with data on food waste arising in kerbside refuse, 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 are available (§3.4).

3.1 Coverage by levels of deprivation

Coverage in terms of levels of deprivation is illustrated for English local authorities in Figure 3.1. The black line indicates Indices of Multiple Deprivation (2007) for all local authorities in England, and the blue bars indicate levels of deprivation for those local authorities included in the study group. Figure 3.1 shows reasonable coverage for England in terms of levels of deprivation.

Indices of Multiple Deprivation are also available for the other 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. This is not an ideal method, since these data are now somewhat out of date. However, an analysis, comparing this measure of deprivation with the various Indices of Multiple Deprivation for the different nations, shows that the two measures are highly correlated. This indicates that the 2001 Census data provide 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 3.2. The black line indicates proportions of local authority populations of Social Grade D or E, and the blue bars represent those local authorities contributing data on food waste in kerbside refuse to the study. Figure 3.2 shows that coverage across the UK for this measure of deprivation is good.

3.2 Coverage by region and nation

The coverage of the sample local authorities by English region is shown (for England authorities only) in Table 3.1. Coverage by region is poor, with London being heavily over-represented in the sample, whilst no data are available for authorities in the North East, North West or West Midlands regions. However this is not a significant concern, as region was not found to be significantly correlated with differences in waste composition in the WR0119 project (§1.2).

Table 3.1 Breakdown of **local authorities** by England region – population and sample

Region	England		Sample local authorities	
	No. LAs	% of LAs	No. LAs	% of sample
East Midlands	40	12.3%	7	14.6%
Eastern	47	14.4%	2	4.2%
London	33	10.1%	17	35.4%
North East	12	3.7%	0	0.0%
North West	39	12.0%	0	0.0%
South East	67	20.6%	12	25.0%
South West	37	11.3%	8	16.7%
West Midlands	30	9.2%	0	0.0%
Yorkshire & the Humber	21	6.4%	2	4.2%
Total	**326**	**100.0%**	**48**	**100.0%**

Figure 3.1 Coverage of local authorities performing compositional studies (Indices of Multiple Deprivation): England only

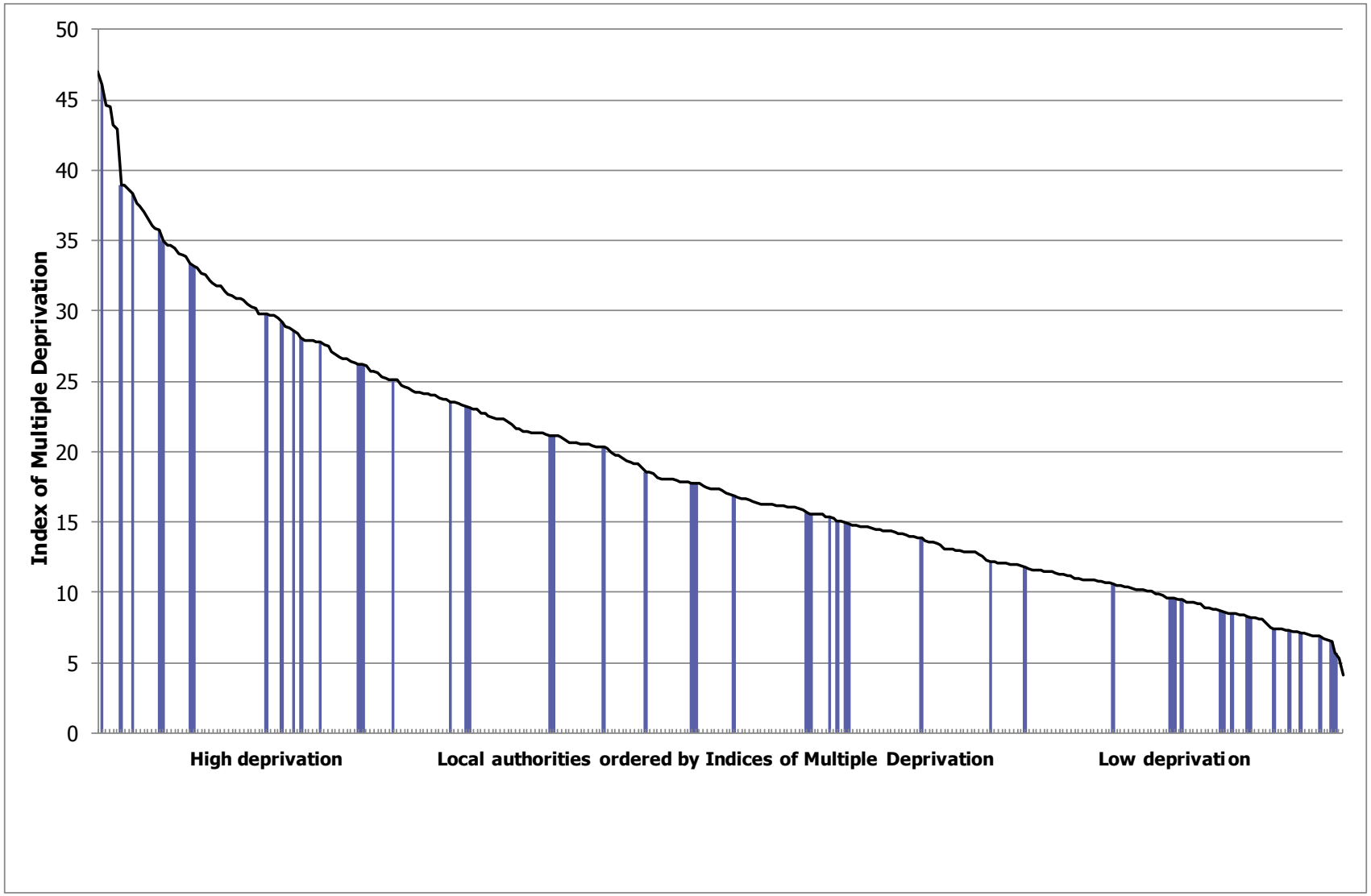
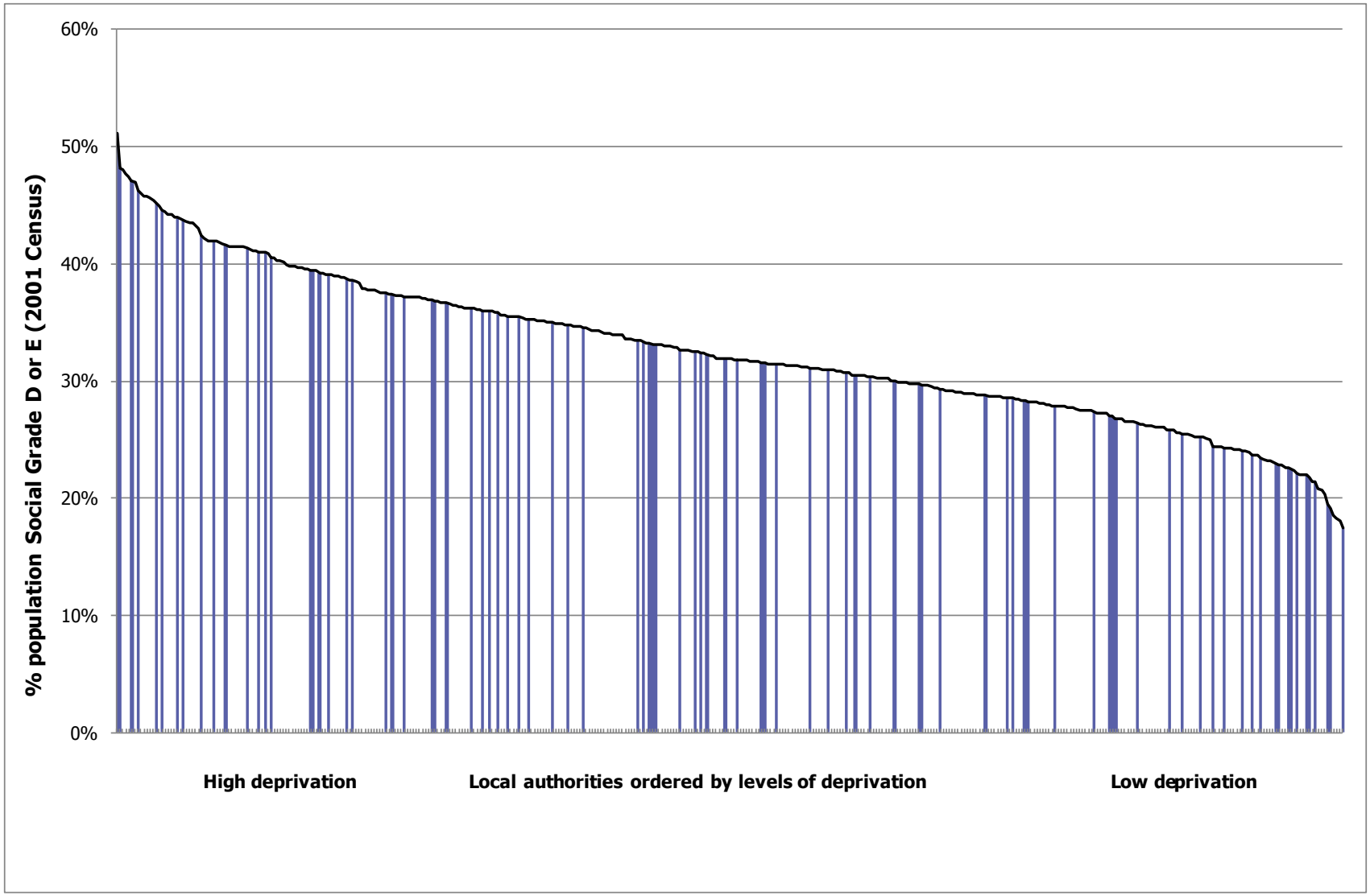


Figure 3.2 Coverage of local authorities performing compositional studies (levels of deprivation): UK



An assessment of coverage by nation in the UK is presented in Table 3.2, which shows a bias towards Wales (with nearly every authority in Wales included) and significantly lower coverage for the other nations. However, this is not problematic, as the UK picture has been built from nation level up, and thus Welsh data does not disproportionatly influence the final estimate. There is reasonable coverage within each nation.

Table 3.2 Coverage by nation in the United Kingdom

Nation	All United Kingdom	Sample local authorities
	No. LAs	No. LAs
England	326	48
Wales	22	21
Scotland	32	12
Northern Ireland	26	6
Total	**406**	**87**

3.3 Coverage by collection system

Coverage of different types of collection system for the English kerbside refuse data sample and the national profile is compared in Table 3.3. We can see that there are some mismatches between coverage levels in the sample, in comparison to the national profile for England; for example, fortnightly refuse collections are under-represented in the sample.

However, the most important coverage issue is the overrepresentation of authorities which target food waste at the kerbside for treatment (in separate food waste or mixed organics collections). As discussed in §2.4, this means that the sample is skewed towards local authorities which tend to have slightly lower food waste arisings in kerbside refuse, due to some food waste being diverted to separate or mixed organics collections. Therefore, the samples have been stratified and weighted to account for this effect, in order to produce robust national estimates for arisings of food waste in kerbside refuse in England (§2.4).

Table 3.3 Coverage by collection system

Collection system	England		Sample local authorities	
	No. LAs	% of LAs	No. LAs	% of sample
All collections targeting food waste at the kerbside for composting	126	38.7%	27	56.3%
Separate food waste collections	72	22.1%	17	35.4%
Fortnightly refuse collections	155	47.5%	18	37.5%
Separate food waste collections + fortnightly refuse	*45*	*13.8%*	*8*	*16.7%*
Total	**326**	**100.0%**	**48**	**100.0%**

Samples for Scotland and Wales were stratified in a similar manner to reflect the national profile of local authorities targeting food waste at the kerbside for composting in each respective nation. The scarcity of compositional data for Northern Ireland meant that it was not possible to stratify the sample in this way.

3.4 Coverage by period and waste stream

All the waste compositional studies included in this report (with the exception of Northern Ireland) were performed after 2009, i.e. subsequent to those included in the previous WR0119 project (§1.2). The coverage of these datasets, in terms of the period during which audits were carried out, is illustrated in Table 3.4. The numbers of studies included for each waste stream (kerbside residual, kerbside dry recycling and HWRC residual) are indicated, as well as the the numbers of multi-phase projects for each waste stream.

England shows good coverage for a baseline year of 2010, although quite a few of the studies were carried out in 2009. Scotland's coverage is less ideal, although the targeting of food waste at the kerbside was similar in 2009 (the earliest year for the Scottish studies) and 2010 (the WasteDataFlow baseline year). Many of the Scottish studies were carried out as part of Zero Waste Scotland's *The composition of municipal solid waste in Scotland (WastesWork and AEA)* project. Wales presents a particular challenge in terms of coverage, since all the audits were carried out in 2009, as part of WRAP's *The Composition of Municipal Solid Waste in Wales (WastesWork and AEA)* project. The lack of coverage in 2010 and the increase in organics collections in Wales between 2009 and 2010 means that national estimates for Wales have been arrived at by analysing waste compositional data alongside a hybrid of 2009 and 2010 WasteDataFlow tonnages (§2.3.1).

Table 3.4 Number of compositional audits split by year, country and waste streams covered

		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**
	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**

Compositional data are especially problematic for Northern Ireland, where the only data available are for the 2007 study for the Environment and Heritage Service of Northern Ireland, *Review of Municipal Waste Component Analyses, RPS.* As discussed in §2.3.1, total kerbside food waste arisings have been inferred from the 2007 kerbside refuse datasets, and the targeting of food waste at the kerbside in 2010 has then been factored in.

3.5 Coverage by season

Table 3.5 shows the number of phases of auditing by season for each nation, relating to compositional data for kerbside refuse included in this study. The seasons have been defined as follows:

- Winter: December, January, February.
- Spring: March, April, May.
- Summer: June, July, August.
- Autumn: September, October, November.

There are different biases for each nation. A review of single phase data from the Defra WR0119 project indicates that there is limited seasonal variation in food waste, though with slightly higher arisings in autumn (see Appendix 1). Although there are biases relating to the under- or over-representation of autumn audits in each of the nations, it is considered unlikely that these biases will have significantly affected the national estimates presented in this report.

Table 3.5 Number of phases of auditing for kerbside refuse compositional data

	Winter	Spring	Summer	Autumn
England	9	22	12	24
Wales	21	0	21	0
Scotland	0	12	0	10
Northern Ireland	6	0	0	6

4.0 Estimates for household food waste arisings collected by local authorities

This section presents estimates of LA-collected household food waste arisings during 2010 for the UK (§4.1), and compares England's 2010 estimates with previous 2006/07 estimates (§4.2). Sensitivity analyses are also carried out (§4.3). A paired comparison of local authorities for which both 2006/07 and 2010 data are available (all in England) was carried out (§4.4), and an analysis of 2010 data of the potential effects of various factors in food waste arisings is presented (§4.5). Finally, an account of food waste thought to arise in street sweepings and litter is included (§4.6).

A definition of the waste streams included in "LA-collected household food waste" can be found in §1.1.

4.1 LA-collected household food waste arisings in the UK in 2010

Tonnage estimates for total LA-collected household food waste arisings for the UK in 2010 are shown in Table 4.1. Arisings in terms of kg per household per year are presented in Table 4.2. Readers should note that over 80% of LA-collected household food waste in the UK arises in England.

Table 4.1 Estimated annual tonnage LA-collected household food waste arising in the UK in 2010

Food waste arisings (tonnes)	UK
Kerbside refuse	4,167,020
Kerbside dry recycling (contamination)	58,594
Kerbside organics collections	305,764
HWRC residual	87,206
Total	**4,618,584**
95% confidence interval*	±160,000

*The confidence interval is stated to two significant figures and includes sampling errors, but does not include other uncertainities (see Appendix 4)

Table 4.2 Estimated annual arising of LA-collected household food waste in the UK 2010, kg/hh/yr

Food waste arisings (kg/hh/yr)	UK
Kerbside refuse	155.3
Kerbside dry recycling (contamination)	2.2
Kerbside organics collections	11.4
HWRC residual	3.3
Total	**172.2**
95% Confidence Interval*	±6.8

*The confidence interval includes sampling errors, but does not include other uncertainities (see Appendix 4)

As greater uncertainty surrounds individual nation figures, they are not individually presented. Taking into account sampling error, the only apparently significant difference in overall waste arising is between England and Wales. However, there are other sources of uncertainity in the analysis, for example regarding the amount of food waste in mixed collections (§4.3.1), and thus there is insufficient evidence to state definitively that there are genuine differences in per household arisings in these two cases. Equally, it cannot be definitively stated on the basis of this analysis that there are not nation-level variations in arisings. More nation level analysis would be desirable, but this uncertainty does not effect our confidence in the overall UK estimates (see Appendix 3).

Uncertainity in the estimates is discussed in more detail in appendix 4.

4.1.1 Secondary level composition of food waste in kerbside refuse

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 refuse (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 subcategories, in order to maximise the number of studies whose data on food waste subfractions could be harmonised. The subcategories 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. unedible food waste, such as peelings, bones, etc).

The classification does not include a category of 'possibly avoidable' waste and this material was split between 'avoidable' and 'unavoidable' (see below).

The results of this analysis are shown in Table 4.3. Far more data are available for the home compostable and non-home compostable subcategories, with these subcategories being identifiable in 67 of the collated studies. The analysis suggests that there are roughly equal arisings of Home and Non-home compostable food wastes.

Table 4.3 Secondary level compositional assessment of food waste arisings in kerbside refuse

	Home-compostable food waste	Non-home compostable food waste	Avoidable food waste	Unavoidable food waste
No. studies	67	67	5	5
Average	47.1%	52.9%	60.1%	39.9%
95% confidence interval	±2.1%	±2.1%	±4.7%	±4.7%

In terms of avoidable and unavoidable food waste, the data suggest that arisings of avoidable food waste are somewhat higher than unavoidable food wastes. It is interesting to compare this split with that in *Household Food and Drink Waste in the UK*, which identified 60.2% of food waste collected by local authorities as avoidable. However, the classification in this latter report split the material into three categories (avoidable, possibly avoidable and unavoidable).

However, there are some differences in the classification of the types of food between the five studies identified in the current research (all undertaken by the same contractor) and *Household Food and Drink Waste in the UK* . In particular, all five studies classified most of the possibly avoidable items as avoidable, with the exception of vegetable peelings, which would probably have been categorised as unavoidable.

The *Household Food and Drink Waste* data has been re-assessed to be as consistent as possible with the figures quoted in this study, in particular reclassifying:

- the possibly avoidable vegetable and salad waste (700,000 tonnes) as unavoidable (alongside all unavoidable waste in *Household Food and Drink Waste*); and
- all other possibly avoidable waste as avoidable.

This gives a split of 67% avoidable and 33% non-avoidable and therefore this analysis suggests that the proportion of avoidable food may have decreased, as would be expected through waste prevention activities. However, **these results and the conclusions drawn should be treated with caution** because the number of studies (five) is very small and they come from geographically clustered studies. Estimating the reduction in avoidable household food waste is discussed in more detail in *New estimates for household food and drink waste in the UK*[10].

[10] www.wrap.org.uk/hhfwfacts

4.1.2 Food waste in HWRC residual

The average arising of food waste in HWRC residual for areas with separate food waste collections was 4.0%, compared to 3.1% for other areas. However, this difference is not significant at the 95% confidence level due to a limited sample (data from only 9 authorities). Therefore, this report does not find evidence that separate food waste collections are associated with the significant diversion of food waste to HWRC residual waste.

4.2 England: comparison with previous estimate

Comparisons with the 2006/07 LA-collected household food waste estimates for England from the previous WR0119 project (§1.2) are shown in Table 4.4, Table 4.5 and Figure 4.1. The WR0119 compositional estimates for England in 2006/07 did not account for food waste arising in kerbside dry recycling (as contamination). In order to make the 2006/07 and 2010 estimates comparable, an estimate of food waste arising in kerbside dry recycling has been included for 2006/07 (which was not included in the WR0119 project). This estimate has been arrived at by applying the proportion of food waste estimated to arise in kerbside dry recycling in England in 2010 (1.6%) to kerbside dry recycling tonnages for England in 2006/07.

Table 4.4 Comparison of national food waste arisings estimates for England – tonnes

	2006/07	2010
Kerbside refuse	4,457,189	3,450,009
Kerbside dry recycling (contamination)	44,973	55,520
Kerbside organics collections	51,096	245,886
HWRC residual	101,094	67,114
Total	**4,654,352 ± 158,000**	**3,818,529 ± 143,000**

* Confidence intervals are stated to three significant figures

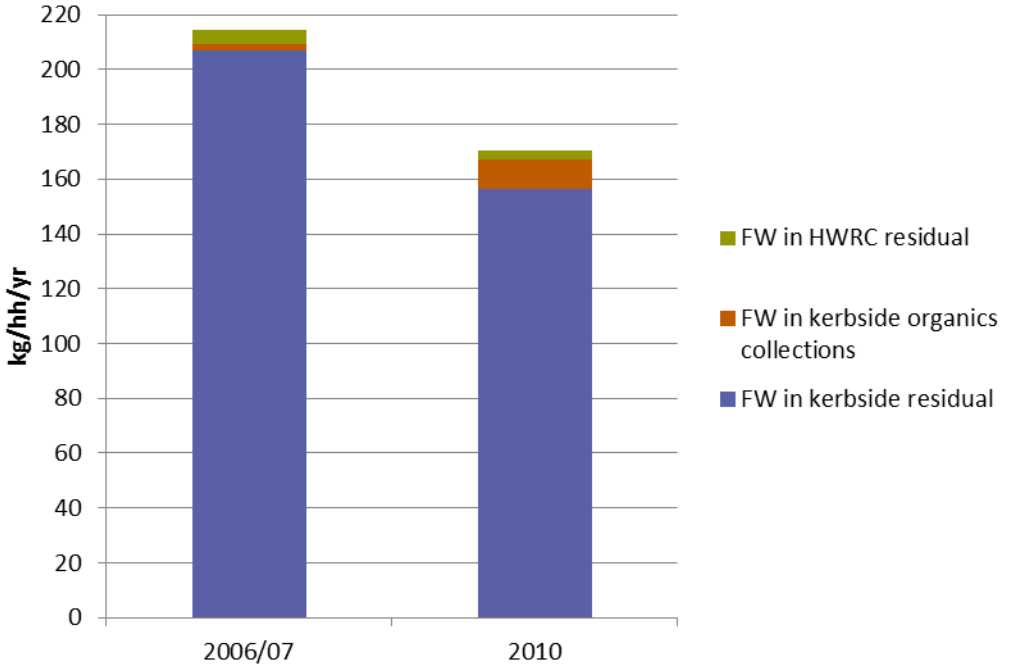
There has been a significant reduction in LA-collected household food waste tonnages in England between 2006/07 and 2010, of around 840,000 tonnes (to two significant figures) – a reduction of 18%. This reduction occurred against a backdrop of growth in household numbers, with an estimated 4.2% increase in the number of households between 2006/07 and 2010. In terms of kg per household per year, arisings of LA-collected household food waste have reduced by 46 kg/hh/yr, or a 21% reduction.

Table 4.5 Comparison of national food waste arisings estimates for England – kg/hh/yr

	2006/07	2010
Kerbside refuse	207.1	153.9
Kerbside dry recycling (contamination)	2.1	2.5
Kerbside organics collections	2.4	11.0
HWRC residual	4.7	3.0
Total	**216.3 ± 7.4**	**170.3 ± 6.4**

Care has been taken to use the same methodology and assumptions for arriving at each estimate (see §2). Combining the confidence intervals of the 2006/07 and 2010 estimates leads to a 95% confidence interval around the reduction of ±210,000 tonnes, or between 630,000 and 1,050,000 tonnes.

Figure 4.1 Comparison of national food waste arisings estimates for England (kg per household per year)



4.3 Sensitivity analyses

4.3.1 Mixed organics collections

One main uncertainty in this analysis relates to the proportion of food waste in mixed organics collected at the kerbside (§2.3.2). A sensitivity analysis was carried out by doubling this proportion (from 21.2% to 42.4% for weekly organics collections, and from 14.7% to 29.4% in fortnightly organics collections) and noting the impact on the results. Table 4.6 shows these results.

Table 4.6 Sensitivity analysis illustrating the effect of doubling the proportion of food waste assumed to be in mixed collection; results in kg per household per year

All household food waste, kg/hh/yr	UK
Standard assumptions	172.2
Alternative assumptions	177.1
Percentage difference	*2.9%*

Changing the assumptions, results in only a relatively small increase in the total LA-collected household food waste for the UK. A greater difference would be observed in Wales or Northern Ireland, where a higher proportion of food waste is collected through mixed kerbside organics collections.

4.3.2 Inclusion of outliers

Data from two local authorities – one in England and one in Wales – were omitted from the study as they indicated extremely low levels of food waste (§2.2). The inclusion of the outliers has a small impact on the overall results: a 0.5% reduction in the UK estimate for LA collected food waste. This shows that the decision to exclude outliers does not have a large impact on the results or conclusions drawn.

4.4 Paired comparison of food waste arisings

A separate analysis was carried out for authorities with food waste compositional data both for 2006/07 and 2010, to attempt to identify any patterns in changes in food waste arisings for these authorities between these two periods. These data were available for 20 authorities in England. The average reduction in LA-collected household food waste arisings from 2006/07 and 2010 for these authorities was 70 kg/hh/yr, somewhat in excess of the average reduction for England of 46 kg/hh/yr (§4.2).

The effects of changing collection systems (introducing food waste collections, fortnightly refuse collections or both) were investigated for these authorities. However statistical tests showed that the samples available were too small for any meaningful conclusions to be drawn (7 of these local authorities had introduced collections for treatment, whilst 13 had no change relating to food waste collections).

4.5 Effects of factors on food waste arisings

An analysis of the potential effects of various factors on food waste arisings was carried out, with data available for 89 authorities across the UK. The analysis found:

- No significant correlation between kerbside food waste arisings and the provision of separate food waste collections.
- No significant correlation between kerbside food waste arisings and levels of deprivation.
- Lower levels (but not significant at the 95% confidence level) of food waste arisings associated with areas with fortnightly refuse collections (average 165 kg/hh/yr for areas with fortnightly refuse collections, average 179 kg/hh/yr).

The lower arisings of food waste found with fortnightly refuse collections is in line with other evidence on the general waste reduction effect of fortnightly refuse; for example, refer to *WR0121 – Understanding Waste Growth at Local Authority Level, Resource Futures on behalf of Defra, 2009*[11]. However, this finding should be treated with some caution, as various factors can be expected to affect the arisings of food waste at the kerbside. For further comments on this issue, refer to §2.4.

4.6 Food waste arising in street sweepings and litter

Several compositional datasets for street sweepings and litter were collated during the project. These waste streams have not been considered in the national estimates for LA-collected household food waste arisings (see §1.1). However, for completeness, the compositional data for these waste streams are summarised in Table 4.7. Food waste arisings have been expressed as average percentage arisings for each of the waste streams, as determined from the collated waste compositional studies. It should be noted that (according to the compositional data) the proportion of food waste in each stream varied widely, and only a limited number of studies are available. Therefore, these estimates should be treated with caution.

Table 4.7 Compositional data on food waste arisings in street sweepings and litter

	Litter	Street sweepings
Average	13.6%	7.9%
Minimum	0.0%	0.0%
Maximum	36.5%	30.0%
No. studies	36	11

Data on tonnes of litter and street sweepings collected cannot be identified in WasteDataFlow, since these materials are included in the "Other Household Residual" waste category which includes other wastes (notably bulky waste collections).

The Defra WR0119 study (§1.2) estimated the arisings of litter and street sweepings for England in 2006/07 by analysing operational tonnages from a number of local authorities. However, these data did not distinguish between litter and street sweepings, which is likely to be because these wastes are often co-collected in the same vehicle (and therefore separate weights for collected litter and street sweepings could not be recorded).

Therefore, the Defra WR0119 study could only provide estimates for the arisings of litter *and* street sweepings, amounting to an estimated 40 kg/hh/yr, for England in 2006/07. If we assume the same arisings of street sweepings and litter in England during 2010, this would equate to 903,000 tonnes (to three significant figures).

[11] http://sciencesearch.defra.gov.uk/Document.aspx?Document=WR0121_8316_FRP.pdf

If we apply an average food waste arisings figure across the litter and street sweepings (as per Table 4.7) we arrive at an estimate of 10.7% of litter and street sweepings consisting of food waste[12], equating to around 101,000 tonnes of food waste in street sweepings and litter in England in 2010. This is broadly in line with the findings of the Defra WR0119 project, which estimated that around 110,000 tonnes (to three significant figures) of food waste arose in street sweepings and litter in England during 2006/07.

[12] This effectively assumes that tonnages of *litter* and *street sweepings* are equal, though as discussed in this section there are no data available on the relative arisings of these waste streams.

Appendix 1: Analysis of seasonal variations in food waste arisings

An analysis of seasonal variations in LA-collected household food waste arisings was carried out to investigate whether seasonal variation is small enough to enable single phase waste compositional studies to be included in the production of updated estimates of national LA-collected household food waste arisings (see §2.2).

Data from the Defra WR0119 project (§1.2) were analysed for this task. These data relate to England in 2006/07. 120 compositional datasets for kerbside residual waste were included in the WR0119 study, all of which were multi-phase. For each of these studies, separate data on food waste found in kerbside refuse were extracted for each phase of the respective study (where separate data by phase was available); separate phase data were available for 100 districts in England.

It was considered that arisings of food waste in kerbside refuse would provide a good indicator of total arisings of LA-collected household food waste, as the period being analysed was 2006/07, when comparatively little food waste was targeted at the kerbside for composting.

The seasons have been defined as follows:

- Winter: December, January, February.
- Spring: March, April, May.
- Summer: June, July, August.
- Autumn: September, October, November.

Average arisings of food waste in kerbside refuse in terms of kg per household per year are shown in Table A1.1 and Figure A1.1, with 95% confidence intervals included in Table A1.1, and represented by the red "error bars" in Figure A1.1. Figure A1.2 shows similar data with food waste arisings expressed in terms percentage arisings in kerbside refuse. These figures show that there is indeed limited variation in food waste arisings by season.

The higher arisings of food waste in autumn (Figure A1.1) are statistically significant at the 95% confidence level. However, the degree to which arisings in autumn exceed arisings in other seasons is relatively small, with the mean arisings value for autumn ranging from 8 to 10% higher in comparison to other seasons. This suggests that compositional data derived from single phase studies will only be significantly affected by seasonal variations if the samples are skewed very heavily in favour of, or against, the inclusion of audits carried out in the autumn. This has not been the case for the analyses presented in this report.

Table A1.1 Seasonal variation in food waste arisings in kerbside refuse, average for 100 districts in England, 2006/07

	Winter	Spring	Summer	Autumn
Mean arisings (kg / hh / yr)	168.3	170.5	167.8	184.3
No. of phases	60	59	48	79
95% confidence interval (kg / hh / yr)	±10.5	±10.8	±10.3	±10.7

Figure A1.1 Seasonal variation in food waste arisings in kerbside refuse, average for 100 districts in England, 2006/07 (kg per household per year)

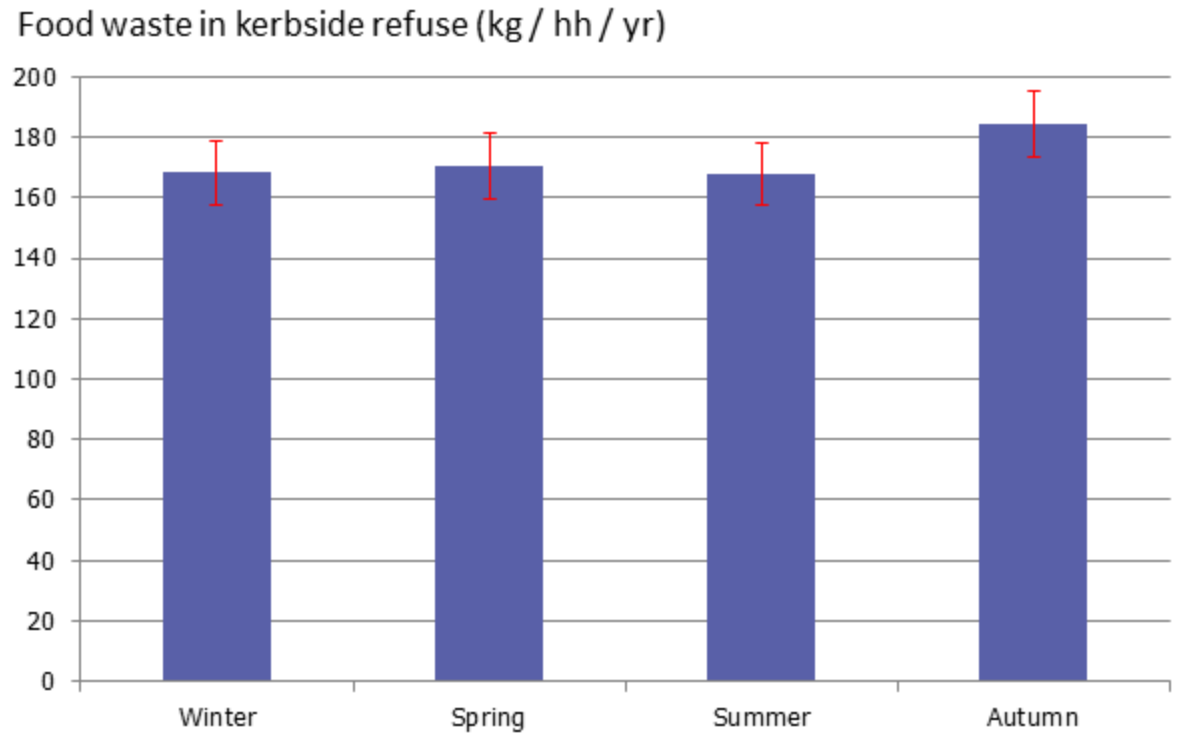
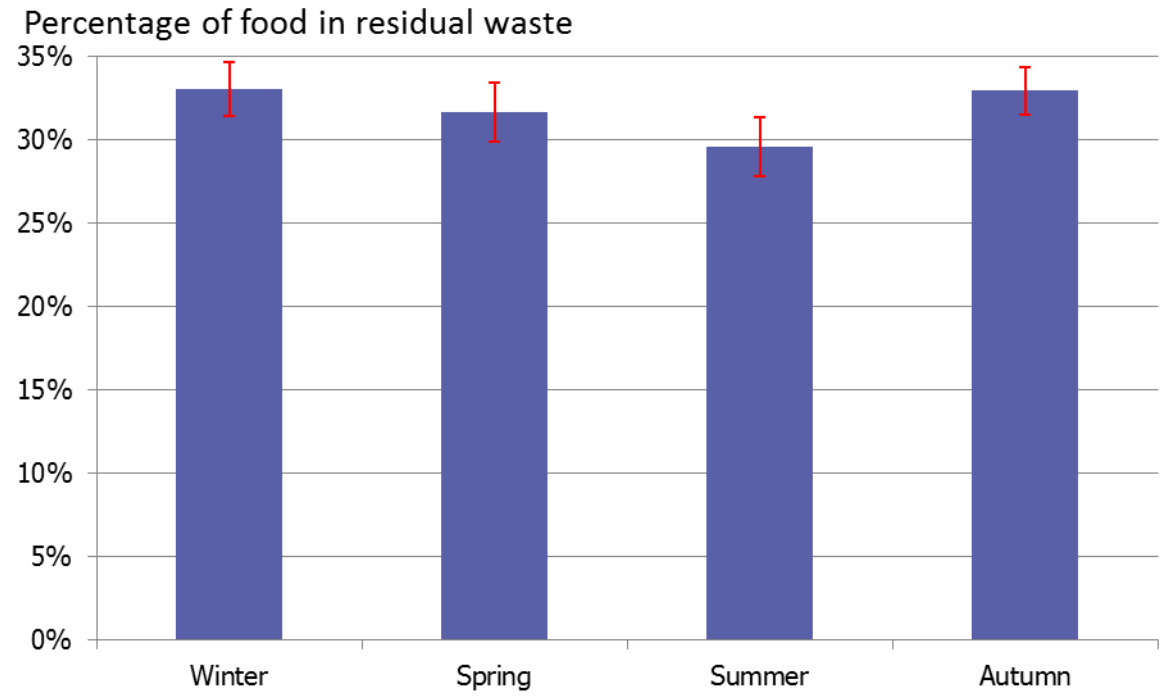


Figure A1.2 Seasonal variation in percentage of residual waste that is food, average for 100 districts in England, 2006/07



Appendix 2: Household counts applied for this study

As discussed in §2.6, household counts for all local authorities in the United Kingdom and for all periods have been standardised so that they are consistent with the household counts used for England 2006/07 for the previous national arisings estimates for the WR0119 study (§1.2). The WR0119 study uses a household count of 21,517,000 for 2006/07, which is in agreement with the 2006 figure from *ONS: Communities and Local Government, Household Projections to 2031, England (2009)*. The same publication produces a projected household count for England for 2011 of 22,647,000. Assuming a linear increase in the number of households for each year, this would mean that the number of households in England in 2010 would be 22,421,000 (an increase of 4.2% between 2006 and 2010).

For the other nations, the total numbers of households have been estimated through reference to *ONS: Communities and Local Government, Household Projections to 2033, United Kingdom (2010)*, and assuming a linear increase in household numbers from 2008 to 2013. The resulting household counts for 2010 are:

- Wales: 1,324,600 households.
- Scotland: 2,374,600 households.
- Northern Ireland: 706,600 households.

Appendix 3: Alternative grossing up methodology

Obtaining national estimates of LA-collected household food waste is complicated and there are many potential methods for scaling compositional data with information from WasteDataFlow. To determine the approximate impact of the method employed, an alternative grossing up methodology was also used, which is described in this appendix.

The alternative grossing up methodology essentially consists of:

1. calculating the arisings per household of the food waste fraction of kerbside residual waste plus recycling for each of the local authorities included in the study;
2. calculating the mean arisings of food waste, in terms of kg per household per year, across all the local authorities included in the study; and
3. multiplying the mean arisings of food waste kg/hh/yr by the number of households nationally.

An important assumption in this method is that the authorities included in the study are reasonably representative of each nation as a whole, i.e. that they provide reasonable coverage. Issues around coverage are discussed below and in Sections 2 and 3.

A worked example is provided here. For local authority *"A"*, for which recent kerbside multi-phase residual waste audit data are available, estimates were arrived at through the following route. Analysis of the audit data (i.e. taking into account all socio-demographic groups audited and across all phases of auditing) indicated that 24.8% of *authority A's* kerbside refuse consisted of food waste.

WasteDataFlow tells us that the total kerbside refuse collected during the calendar year 2010 in *authority A* was 20,570 tonnes. Therefore, the total food waste arising in kerbside refuse for *authority A* is estimated to be 20,570 x 24.8% = 5,108 tonnes.

Authority A has reported through WasteDataFlow that 880 tonnes of mixed food and garden waste were collected during 2010, with these collections being carried out weekly. Applying our estimate that 21.2% of these collections consist of food waste (see §2.3.2), it is estimated that 187 tonnes of food waste arose in *authority A's* mixed food and garden waste collections.

Therefore, the total food waste arising at kerbside for *authority A* during 2009 is estimated to be 5,108 tonnes (in refuse) *plus* 187 tonnes (in organics collections) = 5,295 tonnes. The number of households in *authority A* is reported to be 45,456. The arisings of LA-collected household food waste during 2009 in *authority A* is, therefore, estimated as 5,295 x 1,000 / 45,456 = 116.5 kg/hh/yr.

A similar procedure was carried out for all other authorities where kerbside residual waste audit data were available, resulting in array of information about the weight of food waste arisings per household per year for each authority included in the study. Average arisings per household were calculated as a mean of all these values, weighting the calculation by number of households within each local authority to account for the different sizes of authority. 95% confidence intervals were also calculated from the same array of values.

This alternative method has also been applied to the data collated for this project as part of the sensitivity analysis, the results of which are presented in Table A3.1.

Table A3.1 Sensitivity analysis – different grossing up methodologies

All household food waste, kg/hh/yr	UK
Standard method (Section 2.6)	172.2
Alternative method (Appendix 3)	171.3

The UK picture is little different regardless of which approach is deployed, and, at the UK level, is not statistically significant. Greater variation is seen if such analysis is conducted at nations level. The reasons for divergence

are complex. One factor is that the binary stratification used in the standard method (with sample authorities divided into two strata depending on whether or not they target food waste for treatment at the kerbside – see §2.4) is too crude to account for varying degree of coverage for food waste collections in the sample authorities. In particular, authorities will divert different quantities of food waste from refuse to separate food waste or mixed organics collections depending on the proportion of households served with such collections (all other factors being equal). This can be expected to introduce a small inaccuracy to the 'standard' method, which only uses a binary (food waste collected or not) stratification of the sample authorities. This limitation is largely overcome in the alternative method.

At the individual nation level, the difference between the two methods is sometimes greater. Further work is needed to understand the factors that influence this, and which assumptions might be most applicable in each given case. For this reason no nation by nation analysis is undertaken in this report.

However, at the UK level, as table A3.1 demonstrates, these differences are not significant. This is partly because the methodologies are broadly consistent for England (which accounts for ~80% of UK food waste arisings), and partly because the differences between the methodologies seen at the nation level effectively cancel out when a UK total is calculated. The fact the UK result is very similar for both methodologies lends additional confidence to the results arrived at via the primary analysis. At the UK level, the standard methodology has the benefit of comparability with previous studies.

Appendix 4: Uncertainity in results

The table below lists major potential sources of uncertainty in the results given in this report. Where possible, an indication of the magnitude of these uncertainties is given, although this is not possible for all factors.

Potential source of uncertainty	Type or uncertainty and quantification (where possible)
Sampling by local authority within compositional analyses	**Random and systematic uncertainties** It is not practically feasible or desirable to perform compositional analysis on all households within a local authority, so a sample is drawn. This leads to random sampling errors, which is accounted for in this report and confidence intervals are quoted where appropriate. If households are not selected randomly (which is often the case for practical reasons), there could also be a systematic error if there is a bias in the selection of households. This uncertainty has not been accounted for in this report and – should it exist – would be very difficult to quantify.
Representativeness of local authorities covered by compositional analysis	**Potential systematic uncertainties** There are many factors that may influence whether a local authority performs a compositional analysis. For instance, analysis of the data suggests that local authorities who performed a compositional analysis are more likely to collect food waste for treatment and, if they did, have higher yields across the local authority. The alternative method of scaling up from the sample to the population (Appendix 3) provides some analysis of senstitivity to this issue. The results of the alternative and standard methods differed by around 1.3% for England (although the deviation was greater for other nations). There is an overrepresentation of authorities in southern England (compared to northern England and the Midlands) – a manifestation of the authorities that have decided to perform compositional analyses. If there is a regional difference in trends in food waste arisings, this would add uncertainity to the estimates. If there is a correlation between the amount of household food waste collected by authorities and their likelihood of performing a compositional analysis, a) this would also influence the results and b) not be detectable with the information we hold. The greatest concern would be if there was a substantial change in the strength of this correlation between 2006/7 and 2010, as this would affect the trend reported. However, given the scale of the decrease in food waste arisings reported, and the relatively high number of authorities included, the likelihood of this effect changing the conclusions of this report are small.
Total quantity of waste in relevant streams (reported in WasteDataFlow)	**Potential systematic uncertainties** Information reported to WasteDataFlow undergoes many checks before it is made public. However, it is possible that measurement, classification and reporting errors do occur, which would feed through to the results in this report. It is not possible to quantify the magnitude of these potential errors.
Estimate of food waste in mixed organics collections	**Potential systematic uncertainties** The proportion of food waste in mixed organics collections is highly variable and depends on a range of factors including how the collection is communicated to

	households and the length of time since its introduction. Given this, there is the potential for a systematic error. §4.3.1 details the influence of doubling of the proportion of food waste in these collections. The influence of this (relatively extreme) change would be less than 3% for the UK, although it would be higher for individual nations where mixed organics collections were more common such as Wales and Northern Ireland.
Influence of 'outlier' local authorities	**Potential systematic error** Two local authorities were excluded from the analysis as the level of food waste was more than three standard deviations from the mean. The influence of the decision to exclude them is calculated in §4.3.2 – inclusion has a small impact on the overall results: a 0.5% reduction in the UK estimate for LA collected food waste. This shows that the decision to exclude outliers does not have a large impact on the overall results.

For the sampling uncertainties, 95% confidence intervals have been constructed. This has assumed that the households sampled within a local authority for a compositional analysis represent a small proportion of the total households in that local authority. For this reason, a finite population correction has **not** been applied. Although not performed within this research, it would be possible to weight data from compositional analyses to take into account the variability and sample size within individual studies. This would greatly increase the resource required for the project and the complexity of the calculations.

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