Appendix 10: Statistical review

An independent statistical review of the project was carried out on behalf of Defra by Steve Wisher of Information by Design. The review explored several statistical issues raised by Defra and the project steering group during the project's delivery and these issues were resolved through dialogue between Resource Futures and Steve Wisher. This appendix presents a summary of the statistical review process.

10.1 Statistical review: general observations

Evidence from the report suggests that considerable effort was made to maximise the number of studies to be collated in the review of municipal waste composition. This provides a strong basis for producing national estimates of waste composition. Overall, the estimates of waste composition produced in the draft report appear reasonable and form a sound basis for development of revised estimates in the future.

10.2 Evaluation criteria for kerbside residual datasets

Particularly stringent evaluation criteria were applied in the case of kerbside residual waste, in order to select the 'best' studies for further analysis:

- 2 or more phases of auditing;
- ACORN, Council Tax band, or other socio-demographic stratification of the waste audit samples;
- waste audits with a start date of 2005 or more recent.

This resulted in 120 of the 300 or more kerbside residual datasets being included in the analysis. The statistical review addressed two key issues here:

- what were the justifications for applying such stringent selection criteria?
- what benefits would there be in carrying out analyses of the datasets which failed to meet the selection criteria?

The outcomes of the statistical review in respect of these two issues are summarised below.

10.2.1 Justifications for selection criteria for kerbside residual datasets

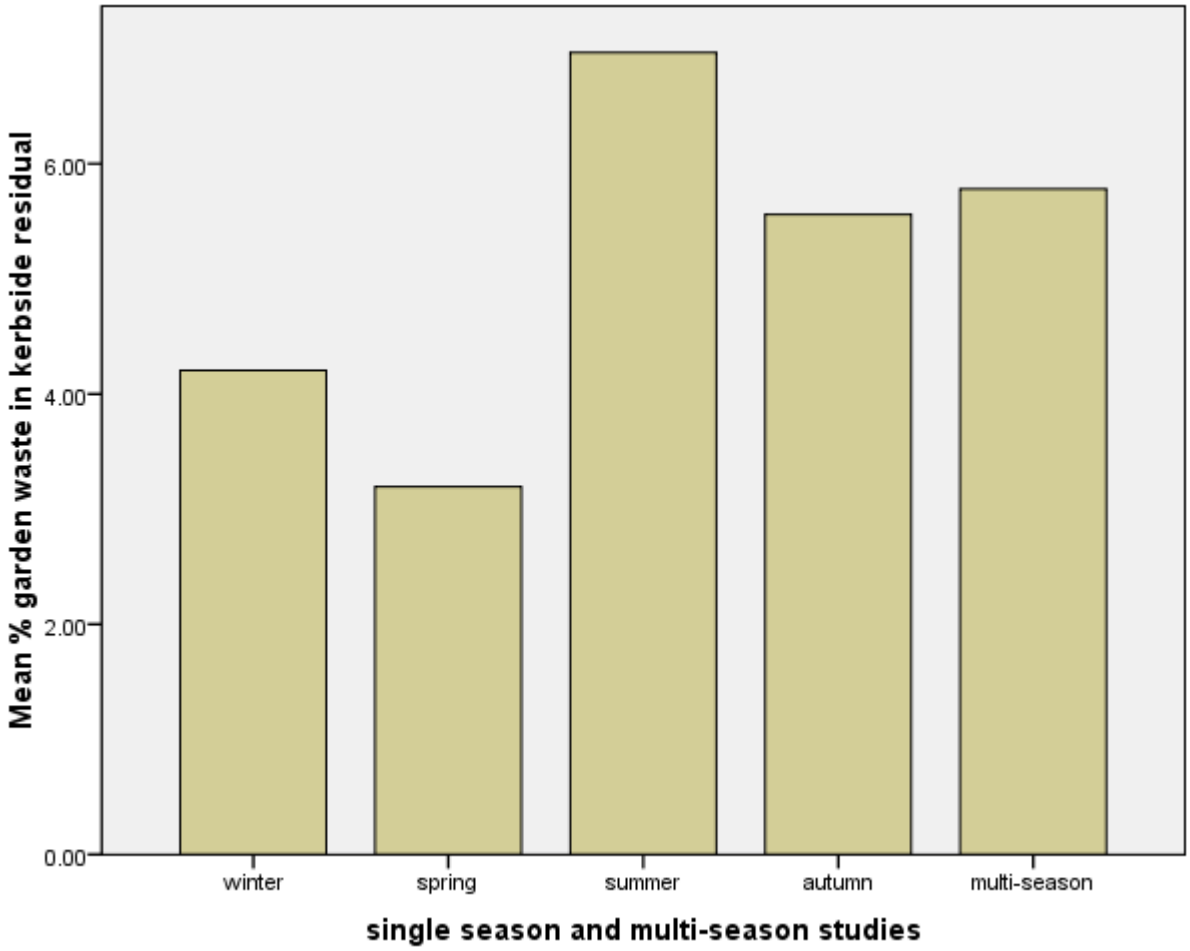
In order to deliver the main research objectives, it was agreed between Defra and Resource Futures that caution was required in avoiding considerable time abstracting and formatting data that might otherwise have been unsuitable. The idea behind concentrating the analysis on the 'best selection' of the data was intended to allow sufficient resource to carry out the analysis and to produce compositional estimates, within the agreed scope of the project.

In respect of only including multi-phase studies, selection criteria were partly based on the methodology used in the 2002 Strategy Unit Report, in which 70 kerbside residual datasets were analysed from single season and multi-season compositional studies. The combined dataset was compared with Defra municipal waste management estimates for residual waste (in terms of kg per household per year). It was found that multi-phase studies correlated better with the annual residual waste returns (kg/hh/yr) reported to the Defra municipal waste management survey. In the case of the 2002 study, of the original 70 kerbside residual studies available, only 27 multi-phase analyses were finally selected for the 2002 compositional estimates. Seasonality in waste

arisings was thought to be a major reason for the differences observed between mean sample weights for residual waste and district level comparators. Although there may be important differences in garden waste policy between 2002 and 2006/07, it is likely that seasonality is still an important influence on waste composition.

Resource Futures carried out further analysis of the issue of seasonality in relation to garden waste. This is a category that is more easily compiled from the collected datasets (an unambiguous category common to all analyses) and is likely to be one of the main sources of seasonal variation in compositional data. Data from all of the single phase studies were compiled and classified by season. Comparisons were then made between the combined garden waste estimates from multi-phase studies and the garden waste estimates from single season studies. The analysis showed statistically significant differences between seasons in the values for garden waste (kg/hh/yr) in both residual and separately collected garden waste. Differences were also apparent between estimates obtained from multi-season studies and the combined results from single season studies.

Figure 10.1: Comparison of garden waste arisings in kerbside residual waste found in multi-season and single season audits



The majority of selected kerbside residual datasets (64%) had 2 phases of auditing, 16% had 3 phases and 20% had 4 phases. Phases sometimes spanned the autumn/winter and spring/summer seasons; for 8 districts (where 2 phases were recorded) they were both single seasons (e.g. both winter data collections). The data shows a significant difference (p=0.015) in the mean residual household waste by number of phases. Studies with 4 phases had a far larger mean collected residual household waste (Table 10.1), which may be linked to 'size' of local authority and funding available to support multi-phase studies.

Table 10.1: Tonnes kerbside residual waste collected per annum per authority, by number of phases of auditing

Collected residual household waste : Regular Collection

number of phases recorded	Mean	N	Std. Deviation
2	37960.74	77	31929.203
3	32493.15	20	20320.102
4	57887.97	24	39702.835
Total	41009.52	121	32987.871

Although authority size might be related to compositional differences, analysing the data in terms of kg per household (rather than mean district-level tonnes collected per annum) suggests that the differences may not be as pronounced as Table 10.1 suggests. Table 10.2 below shows the district-level mean kg/hh/week from WDF by the number of study phases associated with compositional analyses meeting the selection criteria. Although the 4-phase areas produced a higher mean value, this result was not statistically significant compared with means obtained from 2 and 3 phase areas. It should also be recognised that for the purposes of the review, datasets derived from waste partnership areas (typically a county council, possibly also with neighbouring unitary authorities) were split into their constituent districts. Thus, some of the largest groupings of authorities would not appear as separate entities in the review. It is therefore not possible to make links between funding available to support multi-phase studies and the 'size' of local authority.

Table 10.2: Kg/hh/week kerbside residual waste per authority, by number of phases of auditing

phasesum	Mean 1,000s tonnes	N	Std. Deviation
2	11.6182	77	2.95061
3	11.9581	20	1.92176
4	12.5869	24	2.26495
Total	11.8665	121	2.68824

10.2.2 Potential analyses of single phase kerbside residual datasets

It is acknowledged that further analysis of the kerbside datasets that did not meet the selection criteria would be outside the scope of the current project, not least due to the considerable resources required to abstract, format and reconcile such a large and diverse body of data. Nonetheless, it is considered that further analysis of the excluded datasets could potentially be very useful.

The main objectives of such an analysis would be to:

- Further understand the associations between various potential weighting factors and the waste data (level of deprivation, local authority type, etc; plus any additional variables where data could be sourced at an appropriate level). Examples of additional weighting variables might include size of geographical area, population density and individual domains of the index of deprivation.
- Examine for sensitivity in the data and understand if the data exhibits consistent seasonal patterns.
- Examine changes in data year-on-year.
- Understand any differences in estimates from single-stream vs multi-stream data sets.

During the statistical review, a more fundamental set of issues were discussed, relating to whether the sampling strategies employed in the collated datasets were adequate; and whether analysis of the collated datasets could throw any light on this issue. In this respect, it was considered that the following issues were of particular interest:

- Assessment of whether the average sample size for kerbside residual waste audits at a district level (approximately 200 households) is sufficient
- Assessment of whether the stratification methods employed in individual studies were acceptable.
- Degree to which individual studies actually complied with the sampling strategy that they intended to employ.
- Examine any weighting that was applied in individual studies to correct for sampling bias.

The underlying point here is that unless the individual sampling schemes and sample sizes are adequate, correctly designed and complied with, the estimates at local authority level will be less reliable and hence raise questions about the reliability of national estimates produced during this project. This point is difficult to address without examining in detail the sample designs and ACORN profiles of the original datasets. This would involve more than just reading through the original reports, as there is much variation in the quality of background information supplied by contractors in their compositional analysis reports. Issues may or may not include details on sampling strategy, area profiles and compliance with the intended sampling scheme.

In general, it is unlikely that street block sampling at the level of ACORN categories is adequate to cover the variability of waste composition (typically 35-55 households); but sample sizes/ weights are also determined by practicalities and operational issues. However, it is true to say that there is no empirical data on which to base how much larger the sample sizes would need to be in order to reduce sampling errors. This problem is not unique to the UK. For example, elsewhere in Europe there is little empirical data underpinning sampling strategies. The guiding principle that informed the methodology used in this project was that samples stratified by area type were likely to be better than unstratified samples.

Although it lies outside the scope of the current project, it would be very informative to deconstruct the entire database of collated kerbside composition data and examine the issues raised above. However, such an analysis would not be able to address the adequacy of the average sample size of ~200 households per district. Investigating this issue would require waste

audits to be carried out which adopt an experimental design which incorporates increasing the sample sizes to over 200 households per district; and such studies are likely to be beyond those that a local authority is usually willing to fund.

Given that the '2 phases' criterion has been critical in reducing the number of studies included in the analysis, this suggests a possible alternative approach to producing national estimates of waste composition. This would include pulling all studies (perhaps meeting the '2005 start' and 'area stratification' criterion; or perhaps all studies) into one composite dataset and conducting the following analysis:

- Examining the variation in kerbside residual waste by time period of the study.
- Producing national estimates for kerbside residual waste composition at 'time period' level and weighting up the estimates to produce an estimate representative of all time periods.

However, the problem associated with looking at kerbside residual composition by time-frame is that the rapid improvement in recycling infra-structure during the time period 2005-2008 exerts a strong influence; see Figure 10.2 below. Given this problem, the time-frame issue would need to integrate recycling/ composting data in order to expose any genuine differences in total arisings and composition. The results would need to be interpreted very carefully, due to the missing HWRC element and the known interactions between kerbside collection and HWRC. Therefore there significant advantages in keeping the time frame as narrow as possible, and the approach as simple as possible, particularly also given the need to focus on a single WDF reporting year in the grossing-up methodology. The years 2006 and 2007 were the main years for qualifying studies; (see Figure 10.3). If an approach was explored that produced national estimates at the 'time period' level, it would need to be pegged to particular WDF reporting years. Any changing in WDF reporting consistency between years would add another layer of complexity that would pose significant challenges and would need to be carefully considered.

Figure 10.2: Proportion of recyclables in kerbside residual waste by time period, selected kerbside datasets

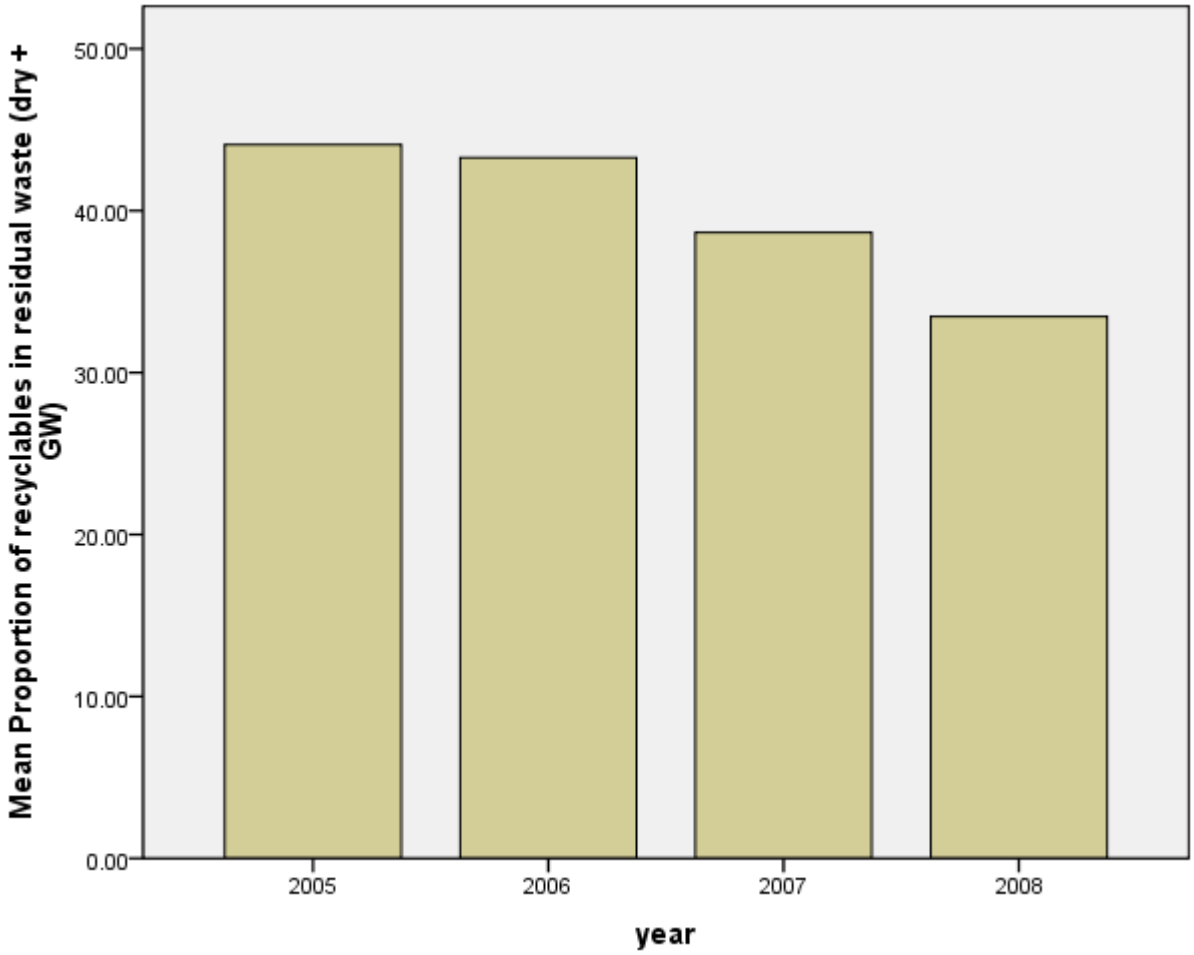
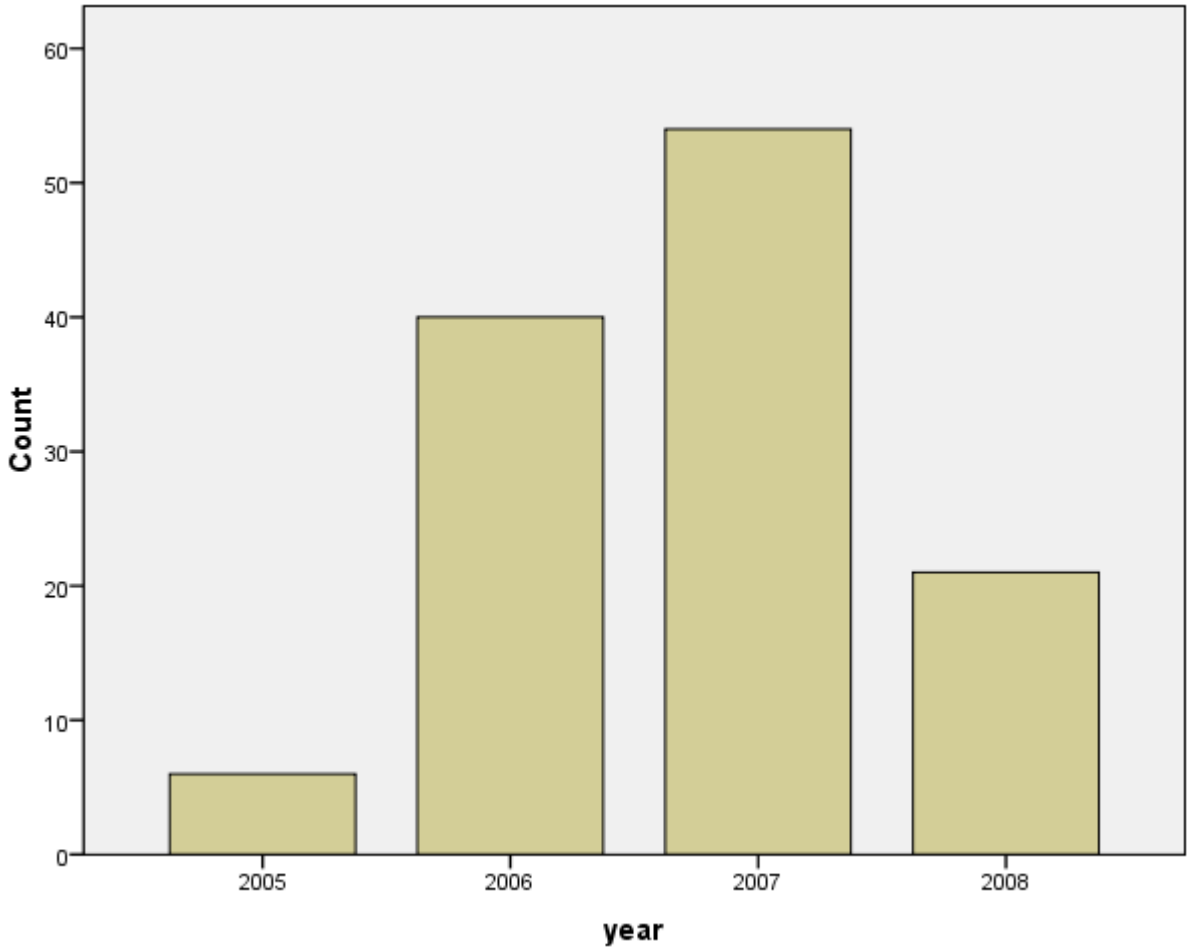


Figure 10.3: Number of selected kerbside residual datasets in each time period



Additionally, the garden waste analysis discussed in Appendix 10.2.1 above, could be taken a stage further by splitting out the multi-season results into their component phases, to see whether or not there were any differences at the level of individual seasons between one-phase and multi-phase studies.

10.3 Confidence intervals

Given the 'wealth' of kerbside data available, stringent evaluation and selection criteria have been applied. For streams where there are fewer datasets available, selection criteria are relaxed to allow sufficient data for analysis and producing the estimates of composition required. The samples of studies and datasets included are therefore not 'probability samples'. This raises questions about the appropriateness of the statistical analysis applied at later stages. For example, confidence intervals can be 'calculated', but it must be borne in mind that the confidence intervals given come from non-probability samples. The difficulties associated with calculating confidence intervals have been considered at length from the outset of the project and are noted, as appropriate in this project's report and appendices.

10.4 Kerbside residual waste: alternative samples

Only a limited number of variables were available to examine whether this was a representative sample of authorities in England. Given that the project collated data from only 'the best' local authority studies, (obviously) no comparison can be made with other local authorities where data has not been collated. To confirm the estimates obtained using the 120 selected authorities, a 'bootstrap' type estimation was conducted. Here 1,000 repeat samples of 50 local authorities were selected from the 120 where data had been collated. From this, estimates of composition were obtained, together with revised confidence intervals of the estimates. Table 10.3 below gives the original estimates of waste composition derived from the data collated by Resource Futures. Table 10.4 below shows the revised estimates obtained from the 1,000 repeat samples.

For example, the mean food waste from the original 120 sample was 13,685 tonnes with a 95% confidence interval of ±1,728 [11,958 to 15,413]. The comparable estimate from the 1,000 repeat samples is 13,709 tonnes with a 95% confidence interval of ±2,086 [11,623 to 15,795].

For each category of residual waste, the means from the 2 methods of estimation are in close agreement. The confidence intervals from the 1,000 repeat samples are always wider than those from the sample of 120 authorities for all categories of kerbside residual waste. For example, for food waste the confidence interval from the 1,000 samples is ±2,086, a 20.7% increase over the confidence interval from the original 120 sample. There is a similar proportional increase in the confidence intervals for the other categories.

Table 10.3: Estimates from the Sample of 120 Local Authorities

Kerbside Residual	Resource Futures Estimates				
	Mean	Count	95% CI	95% CI LL	95% CI UL
Food waste	13685	120	1728	11958	15413
Garden waste	2681	120	652	2030	3333
Other organic	1164	120	171	993	1335
Paper	5548	120	926	4622	6474
Card	2244	120	424	1820	2668
Glass	2105	120	402	1703	2506
Metals	1465	120	246	1220	1711
Plastics	5834	120	782	5052	6617
Textiles	1588	120	251	1337	1840
Wood	470	120	91	378	561
WEEE	510	120	100	409	610
Hazardous	216	120	46	171	262
Sanitary	2033	120	293	1741	2326
Furniture	3	120	4	-1	7
Mattresses	0	120			
Misc combustible	610	120	185	426	795
Misc non-combustible	889	120	257	632	1146
Other wastes	1209	120	382	827	1591
Fines	883	120	198	685	1080

Table 10.4: Estimates from 1,000 Repeat Samples of Size 50 from the 120 Local Authorities

Kerbside Residual	Estimates from 1,000 Repeat Samples				
	Mean	Count	95% CI	95% CI LL	95% CI UL
Food waste	13709	1000	2086	11623	15795
Garden waste	2695	1000	778	1917	3473
Other organic	1168	1000	205	963	1373
Paper	5543	1000	1114	4429	6657
Card	2241	1000	509	1733	2750
Glass	2109	1000	486	1623	2595
Metals	1466	1000	297	1169	1763
Plastics	5832	1000	950	4882	6782
Textiles	1590	1000	306	1284	1895
Wood	468	1000	108	360	576
WEEE	509	1000	124	385	633
Hazardous	217	1000	56	161	272
Sanitary	2034	1000	354	1680	2387
Furniture	3	1000	5	-2	8
Mattresses	0	1000	0	0	0
Misc combustible	611	1000	221	389	832
Misc non-combustible	885	1000	307	578	1192
Other wastes	1204	1000	458	746	1662
Fines	880	1000	233	647	1113

10.5 Kerbside residual waste: investigation of representativeness and potential bias

An initial examination of the kerbside residual waste datasets suggests that there may be some bias in the selected samples of local authorities. For example, the selected kerbside residual datasets show an over–sample in some regions and an under-sample in others; (see Appendix 3, Figure 3.7). Similarly, there appears to be different distributions in terms of levels of deprivation for the selected and non-selected studies; (see Appendix 3, Figure 3.5). The selected sample has approximately 26% in the 4th quartile of most deprived authorities, compared to the non-selected sample which has 31% in the 4th quartile. However, in terms of average IMD score, the mean score for those authorities selected is 19.2, compared with 18.9 for those not selected (no significant difference p=0.710). This may explain why the weighting by IMD had only a limited effect; (see Appendix 4, Figure 4.5).

Clearly any difference would only have been important if key variables in the municipal waste dataset were correlated with IMD. The results show there is some correlation between IMD and both collected residential household waste and kerbside recycling rate; see Figures 10.4 and 10.5 below.

Figure 10.4: Tonnes kerbside residual waste collected per annum plotted against IMD score, 120 selected districts

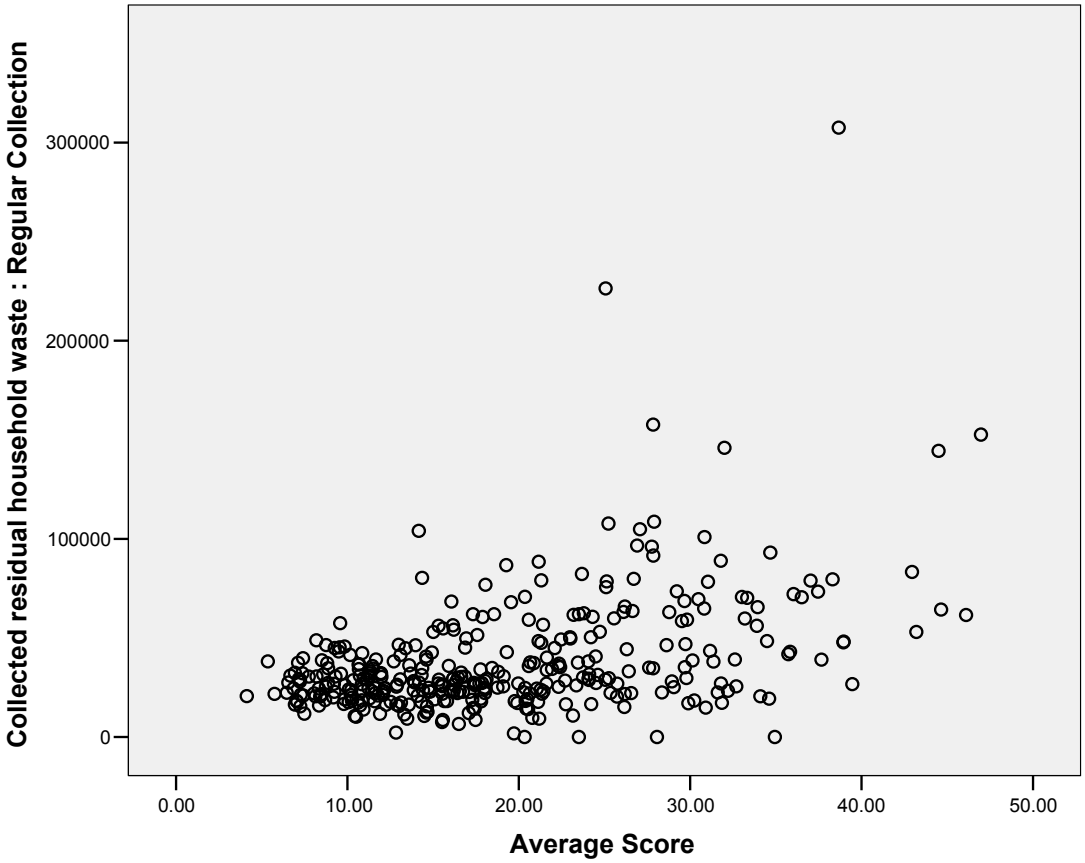
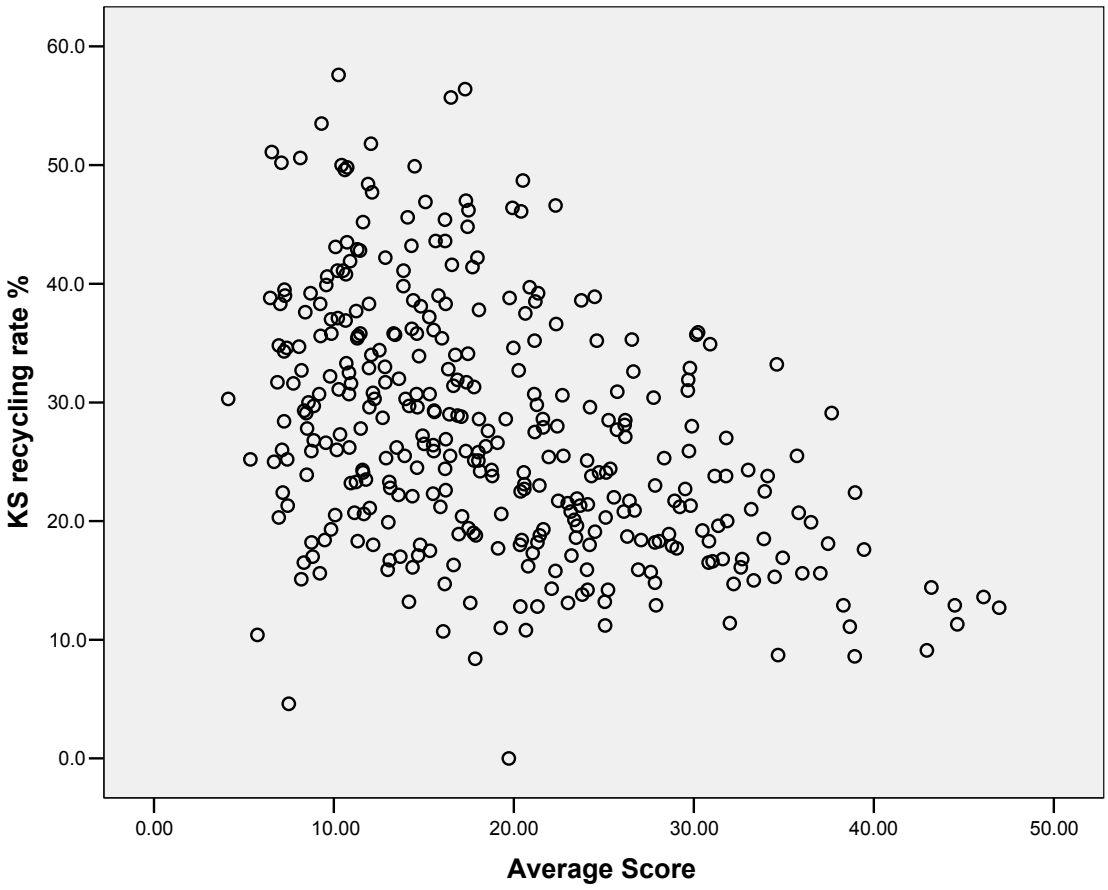


Figure 10.5: Kerbside recycling rate plotted against IMD score, 120 selected districts



Initial analysis of the data from the project on collected residual household waste (with Disposal Authorities removed) shows that there is a difference in the mean residual household waste between those authorities selected and those not selected. The selected sample has a higher average collected residual household waste; the difference is not significant (p=0.112).

Table 10.5: Tonnes kerbside residual waste collected per authority, selected and not selected authorities

Collected residual household waste : Regular Collection

Selected/Not selected	Mean	N	Std. Deviation
Not selected	36034.27	234	27944.11
Selected	41351.26	120	32910.39
Total	37836.64	354	29780.79

There are differences in the mean tonnage of residual household waste per authority by region. The range is from the lowest 27,755 (East Midlands) to the highest 72,496 (Yorkshire). The differences by region are statistically significant (p=0.000).

Table 10.6: Tonnes kerbside residual waste collected per authority, by region

Collected residual household waste : Regular Collection

Region	Mean	N	Std. Deviation
North East	32903.07	23	23976.81
North West	45939.09	43	32658.17
Yorkshire	72496.15	21	55301.86
East Midlands	27755.03	40	16116.97
West Midlands	43390.01	34	51375.76
East of England	29641.86	48	10511.24
London	50695.79	37	24674.42
South East	30889.91	63	11652.54
South West	29100.44	45	16626.39
Total	37836.64	354	29780.79

The results also show differences in mean weight between selected and non-selected authorities by region. For example (see table below), in the North East the mean residential waste of non-selected authorities is 40,864 and 17,977 tonnes for selected authorities. For some regions the difference between selected and non-selected authorities is large is absolute terms (for example, Yorkshire), for others it is much smaller (for example, East of England). For Yorkshire, the selected authorities have a mean residual household waste of 133,718, compared with 53,364 for non-selected authorities. This is a significant difference (p=0.002). These differences may partly be a result of the sample sizes involved. In some regions, only a small number of local authorities have been selected for inclusion (by meeting the selection criteria imposed in the study) in the sample size of 120 (for example, Yorkshire with 5 authorities selected).

Table 10.7: Tonnes kerbside residual waste collected per authority by region, selected and not selected authorities

Collected residual household waste : Regular Collection

Selected/Not selected	Region	Mean	N	Std. Deviation
Not selected	North East	40863.73	15	26105.647
	North West	33909.20	33	19487.955
	Yorkshire	53364.23	16	38738.076
	East Midlands	26721.52	30	17278.474
	West Midlands	46717.83	25	58782.759
	East of England	29902.55	23	11104.731
	London	49603.36	25	23143.795
	South East	31389.41	41	11665.562
	South West	25455.05	26	14309.332
	Total	36034.27	234	27944.113
Selected	North East	17976.82	8	7304.893
	North West	85637.73	10	36677.060
	Yorkshire	133718.27	5	59285.560
	East Midlands	30855.57	10	12222.522
	West Midlands	34146.06	9	19769.411
	East of England	29402.03	25	10158.971
	London	52971.68	12	28557.009
	South East	29959.03	22	11843.757
	South West	34088.88	19	18598.065
	Total	41351.26	120	32910.391

The differences above by region are partly due to population size in the individual regions. Using available population figures, the following table shows residual household waste per head of population by region. Again, there are significant differences by region (p=0.000).

Table 10.8: Tonnes kerbside residual waste collected per person per annum by region

Average collected residual household waste per person

Region	Mean	N	Std. Deviation
North East	.0129	23	.00942
North West	.0067	43	.00478
Yorkshire	.0144	21	.01098
East Midlands	.0065	40	.00377
West Midlands	.0081	34	.00963
East of England	.0054	48	.00191
London	.0068	37	.00332
South East	.0038	63	.00144
South West	.0058	45	.00330
Total	.0069	354	.00606

Any genuine differences in kerbside arisings for selected and non-selected samples by region could result in bias in the estimates of composition. However the differences identified above primarily relate to variations in recycling performance between different local authorities and regions. If total kerbside (residual + recycling) are used, the regional differences largely disappear: see Table 10.9 below.

Table 10.9: Analysis of total kerbside arisings (residual + recycling) per region

WDFtotal_arising

GOR	WAselected	Mean, 1,000s tonnes	N	Std. Deviation
E Midlands	not selected/ none available	24.1617	30	2.55854
	kerbside residual analysis selected	22.6362	10	1.96911
	Total	23.7803	40	2.49197
Eastern	not selected/ none available	24.0119	23	2.51149
	kerbside residual analysis selected	23.4069	25	2.57840
	Total	23.6968	48	2.53783
London	not selected/ none available	20.0652	21	3.23331
	kerbside residual analysis selected	20.3566	11	3.74104
	Total	20.1654	32	3.35844
North East	not selected/ none available	22.2751	15	1.44147
	kerbside residual analysis selected	23.8463	8	3.49163
	Total	22.8216	23	2.40558
North West	not selected/ none available	25.5899	33	3.10886
	kerbside residual analysis selected	25.1866	10	2.73217
	Total	25.4961	43	2.99886
S East	not selected/ none available	23.5323	44	2.90593
	kerbside residual analysis selected	24.2039	23	2.49150
	Total	23.7629	67	2.77021

S West	not selected/ none available	23.7455	26	4.42810
	kerbside residual analysis selected	24.3015	19	2.55036
	Total	23.9803	45	3.72544
W Midlands	not selected/ none available	24.0650	25	2.55711
	kerbside residual analysis selected	23.3677	9	1.92765
	Total	23.8804	34	2.39871
Yorkshire/Humber	not selected/ none available	24.0052	16	2.17799
	kerbside residual analysis selected	22.6365	5	2.54000
	Total	23.6793	21	2.28141
Total	not selected/ none available	23.6721	233	3.21485
	kerbside residual analysis selected	23.5000	120	2.85411
	Total	23.6136	353	3.09394

Examining the data on recycling shows that the sample of 120 selected authorities has a lower kerbside recycling rate than non-selected authorities. Those selected have an average rate of 25.9% compared to 28.2% for those not selected. This difference is significant at the 90% level (p=0.051), but not statistically significant at the 95% level.

A further examination was carried out as part of the statistical review, to investigate if tonnages of kerbside residual collected per authority shows any bias in composition amongst the 120 selected authorities. This was done by 'segmenting' the authorities into 'heavier' and 'lighter' authorities in terms of kerbside residual waste, splitting the authorities into 2 samples of 60 at the median (50^{th} percentile). The mean residual waste composition of 'heavier' and 'lighter' authorities is shown in Table 10.10. This shows, for example, that the proportion of food waste in 'lighter' residual waste authorities is 34.30%, compared with 32.16% in 'heavier' authorities – this is significant at the 90% level (p=0.055). For 5 categories of waste, the difference between 'heavier' and 'lighter' authorities (in terms of residual waste) is significant at the 95% level (p values less than 0.05). Unfortunately with the data available, there is no way of confirming that this difference in waste composition applies to all selected and non-selected authorities.

Table 10.10: Comparison of kerbside residual waste composition for "lighter" and "heavier" kerbside residual waste authorities

Residual category	Low (below Median))	High (above Median))	Total	P value
WA Food waste %	34.30	32.16	33.23	0.055
WA Garden waste %	5.52	6.04	5.78	0.538
WA Other organic %	4.25	2.54	3.40	0.000
WA Paper %	11.39	12.83	12.11	0.011
WA Card %	4.42	5.11	4.77	0.034
WA Glass %	4.15	4.91	4.53	0.010
WA Metals %	3.19	3.32	3.25	0.343
WA Plastics %	14.50	13.29	13.89	0.014
WA Textiles %	3.67	3.63	3.65	0.806
WA Wood %	1.15	1.06	1.11	0.500
WA WEEE %	1.16	1.11	1.14	0.639
WA Hazardous %	0.49	0.50	0.50	0.851
WA Sanitary %	4.52	5.04	4.78	0.171
WA Furniture %	0.02	0.01	0.01	0.407
WA Mattresses %	0.00	0.00	0.00	
WA Misc combustible %	1.01	1.55	1.28	0.055
WA Misc non-combustible %	1.71	1.90	1.81	0.563
WA Other wastes %	2.44	2.97	2.71	0.396
WA Fines %	2.12	2.05	2.09	0.794

Additionally, it was noted that in the 120 selected authorities, 38% have co-mingled systems for dry recycling, compared with 34% in the non-selected sample. Authorities with co-mingled systems have a higher mean collected residual household waste than those with 'other' collection systems. There are also some differences between selected and non-selected samples. For the selected 120 authorities, the mean residual household waste for those with co-mingled systems was 46,091 tonnes; for the non-selected sample it was 36,112 tonnes.

Similarly to the issue relating to differences in kerbside residual tonnages by region discussed above, the analysis here demonstrates that caution is required when examining kerbside residual waste tonnages in isolation from other kerbside streams. For example, the differences between 'heavier' and 'lighter' authorities are shown in Table 10.11 below for total kerbside arisings (residual + dry recycling + composting). It is necessary to look at total arisings because if 'heavy' and 'light' are defined in terms of residual only, the problem of differential performance in recycling becomes the most important influence on residual weight. Using the same approach, but splitting the 120 into 'heavy' and 'light' on the basis of total kerbside arisings gives fewer statistically significant differences. It is most likely that these relate to the method of waste containment, with the 'heavy' authorities having a higher proportion of wheeled bin households in 2006/07 compared with the 'lighter' authorities. This result was highly statistically significant ($F=9.964$, $p= 0.002$). If kerbside data could be perfectly integrated with HWRC data in two-tier authorities, then the influence of the method of waste containment (and frequency of collection) is likely to be greatly reduced. This is because an element of the waste associated with 'lighter' authorities is likely to be represented in a slight increase in HWRC waste in these areas. In the case of black sack collections, heavier fractions, such as DIY wastes, cannot so easily be put into RCV collections and are therefore more likely to be taken by householders to HWRCs.

Table 10.11: Comparison of kerbside residual waste composition for "lighter" and "heavier" authorities in terms of total kerbside arisings (residual + recycling + composting)

	total kerbside arisings light Mean	heavy Mean	F	Sig.
Residual food	33.86%	32.68%	1.10	0.296
Residual garden waste	6.06%	5.53%	0.39	0.536
Residual other organic waste	3.03%	3.72%	2.88	0.092
Residual paper	12.28%	11.95%	0.31	0.576
Residual card	4.59%	4.92%	1.05	0.309
Residual glass	4.60%	4.46%	0.20	0.656
Residual metals	3.17%	3.32%	1.20	0.276
Residual plastics	13.62%	14.13%	1.06	0.306
Residual textiles	3.76%	3.55%	1.64	0.203
Residual wood	0.94%	1.25%	4.81	0.030
Residual WEEE	1.16%	1.11%	0.25	0.620
Residual hazardous	0.49%	0.51%	0.10	0.755
Residual sanitary	4.60%	4.93%	0.76	0.384
Residual furniture	0.01%	0.01%	0.15	0.695
Residual misc. combust	1.30%	1.26%	0.02	0.895
Residual misc non-combust	1.85%	1.77%	0.05	0.827
Residual other	2.94%	2.50%	0.47	0.493
Residual fines	1.75%	2.38%	7.09	0.009
% of households on wheeled bin collections for residual waste 06/07	54.72%	69.14%	9.964	0.002

10.6 Alternative weighting and grossing-up methods for producing national compositional estimates

The majority of selected kerbside datasets include separate compositional data for different socio-economic groups included in the sampling regime for each study, primarily by ACORN group. This suggests that a potential alternative approach producing national compositional estimates, through developing a weighting method for the municipal waste composition data is available (particularly for kerbside data). From the raw datasets for each local authority, estimates would be derived, not from aggregate local authority data, but at the level of data collection itself. For example, in the dataset for each sampling point, there would a number of variables known, including the weight of waste for appropriate categories, together with potential area level weighting factors (IMD variables, ACORN classification, council tax band, etc.). In principle, national estimates could then be obtained by first examining which factors are related to variations in waste composition, and then by using these to 'weight up' to national level.

Similarly from the raw data, it would – in principle – be possible (depending on the variables available) to gross up using socio-economic categories of the individual samples and waste categories. This would involve developing estimates from the ground up by socio-economic group and ignoring local authority. For example, if we know that a meaningful difference in

composition in terms of paper exists by socio-economic group (A, B, C1, C2, D, E), then we can gross up to the national profile of socio-economic groups. The key here would be to use modelling techniques to determine the primary factors influencing the variation in each waste category (for example, examining whether it is socio-economic group, household size/type or other factors which affect the amount of paper collected).

The National Household Waste Analysis Programme (NHWAP), 1992-1995, used a similar approach to grossing-up as that suggested here. The NHWAP methodology depended on the assumption that the compositional profile of residual household waste from an ACORN group sampled in one area would be typical of the profile of household waste in households assigned to the same ACORN group elsewhere (the assumption of homogeneity).

However this approach was considered to be flawed in the review carried out at the time, partly because it failed to take seasonality and collection system types fully into account (Parfitt & Flowerdew 1995[1]). Also, there was no firm evidence that ACORN was a good basis for stratifying areas in relation to variation in waste composition. At that time, recycling rates in the UK were very low (below 4% and limited in the number of materials: mostly glass and paper), so the influence of recycling infra-structure and source segregated waste was less of an issue. With household waste recycling in England now in excess of 35% it would be very difficult to use an ACORN-level approach to grossing-up kerbside data without taking into account the influence of recycling infra-structure. Local waste policies, including side-waste policy, HWRC controls, methods of waste containment, the introduction of AWC for refuse are also likely to have an influence[2].

[1] 'The National Household Waste Analysis Project: Assessment of methods and design criteria for the future'. Paper read to the *First National Conference on Waste Analysis*, Culham Laboratories, Oxon. March 1995.

[2] *Understanding Waste Growth at a Local Authority Level (WR0121)* http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15487