

Appendix 7: Conclusions and recommendations for future work

7.1 Conclusions and recommendations: summary

From the large body of data collated and analysed during this project, it is clear that a great many compositional studies have been carried out at a local level in England in respect of kerbside and HWRC waste streams. In terms of kerbside wastes, it is questionable whether a dedicated national waste analysis programme would contribute significantly to the robustness and statistical confidence surrounding the estimates included in this study, particularly in relation to the resource that would be required in order to undertake such a programme. For example, confidence intervals have been calculated for primary categories of waste types in kerbside residual waste from 120 compositional datasets¹; the addition of a further 120 kerbside residual compositional datasets from a national waste analysis programme would be unlikely to significantly reduce the size of these confidence intervals. In other words, sufficient kerbside residual compositional data (of suitable quality) have been collated and the gathering of further data through a dedicated national programme would currently represent a case of diminishing returns, in respect of improving the robustness of kerbside residual waste compositional estimates .

Nonetheless the review has identified significant data gaps and many areas where future work will be required in order to meet these data gaps. In the first instance, although coverage of kerbside residual compositional data is currently good, it relates to the periods 2005 to the present, and in due course it will obviously become dated. In recent years there has been sufficient demand in the municipal waste auditing market – driven in part by support from central government - for a large number of local kerbside residual auditing studies to be conducted locally in England. If this trend continues, then the priority should be to find a suitable mechanism for encouraging or enforcing standardisation of the waste auditing methodologies employed by the various contractors who carry out waste composition primary data gathering. This applies to municipal waste auditing in general, and not only to the auditing of kerbside residual wastes. Attempts to introduce a degree of standardisation to waste auditing protocols have been made previously, for example with the publication of *Waste Analysis and Guidance for Local Authorities, Entec and Eunomia on behalf of Defra, 2004*. However the range of waste auditing protocols employed by contractors in the collated studies (see Appendix 5) illustrates that this guidance has had limited influence in the industry. Therefore a key recommendation is that further measures are carried out to encourage the standardisation of waste auditing protocols, particularly with a view to ensuring that local studies can support future reviews of UK municipal waste compositional evidence.

There are also significant specific gaps in municipal waste compositional evidence which require particular attention, namely:

- Investigations of variability in municipal waste composition
- Devolved Administrations
- Non-kerbside and non-HWRC waste streams
- Categorisation of recycling tonnages in WDF.

Finally, the datasets collated during this project could be further analysed to provide additional useful compositional evidence.

¹ Appendix 4.3.1.1, Table 4.7

7.2 Standardisation of waste auditing protocols

This study indicates that local data, if made available, can make huge and cost effective contributions to developing national composition at a primary category level. In this context, the key issues are:

- whether the flow of data will continue
- how the proportion of studies failing to meet the selection criteria can be reduced
- whether compositional data gaps are being filled
- whether current and future policy needs are being met.

It is beyond the scope of this report to predict to what degree the flow of local compositional data will continue. However, assuming that the flow will continue to a greater or lesser extent, it is recommended that priority should be given to ensuring a reasonable degree of standardisation in the approaches to waste auditing work carried out locally. In view of challenging recycling targets for local authorities, it is likely that the demand for local municipal waste compositional campaigns will persist. Since local waste auditing campaigns are driven by local needs, there is no guarantee that this flow of data will neatly fill the data gaps identified in this report; or fit well with current and future policy needs. However the encouragement of standardisation may encourage the production of data that is of greater relevance to these drivers. For example, a consistent primary category for WEEE across all local waste audits would assist in assessing the arisings of WEEE in municipal waste.

Nonetheless, it is suggested that the approach to standardisation should be practical and realistic in outlook. The issuing of unduly proscriptive standards or guidance is likely to tempt practitioners to disregard these standardisation attempts, in favour of meeting the requirements of local clients. On the other hand, standards which are too vague or ill defined are likely to be equally ineffective. Therefore we recommend a balanced approach, with clear guidance on those key aspects of waste auditing methodologies which will significantly improve the consistency and utility of locally generated data; whilst being reasonably simple for existing practitioners to incorporate into their protocols.

Whilst a simple and practical approach to standardisation is recommended, there is certainly a case for close examination of some aspects of existing protocols to be carried out. This would not necessarily lead to recommending wholesale changes in waste audit protocols, but could significantly increase our understanding of the robustness of current approaches. For example, most contractors stratify kerbside samples by ACORN group and it could be fruitful to further investigate whether this is the most appropriate approach; see Appendix 7.3.

In summary, this report has illustrated some key features associated with how waste analysis protocols and classification systems have developed over time to respond to changing data needs; (see Appendix 5). Whilst the methods used across kerbside studies have tended to converge, there are several different approaches to auditing HWRC wastes. Moreover, in terms of categorisation of waste components there is a fairly diverse approach between contractors and between waste streams. When looking at specific campaigns, the influence of client purpose, resources and time constraints often tend to add to the diversity of procedures applied. Clearly if the large effort and cost that is expended on waste analysis in locally funded campaigns is to have maximum utility at a national level, a higher degree of consistency is needed.

7.2.1 Standardisation of categorisation

The move away from primary categories that only focus on material content to include “waste types” of legislative importance (hazardous wastes, WEEE, etc) is a trend that is causing increasing problems and a view will need to be taken on whether this trend should be reversed or accommodated in any standard guidance. Both routes offer drawbacks and benefits and both could be designed to permit consistent presentation of both a material based or mixed product-

material based presentation. On balance, a return to a primary classification list based on material type is likely to be more cost effective option at national level, as it is better suited to a wider selection of waste streams from domestic, commercial and light industry sectors.

Furthermore, it would probably permit a wider range of locally funded data to contribute to national data, since it would then lend itself to meeting the most common purpose of such campaigns, namely the identification of material suitable for recycling and energy recovery. This does not preclude subcategory definitions that address the waste/product classifications associated with producer responsibility, but is likely to mean either more than one tier of sub-categorisation is needed, or a selection of subcategory lists that are developed for specific purposes whilst maintaining the ability to be collapsed into the main material based categorisation at a primary level. As a general point, having to move from 13 primary to up to 80 subcategories in a single step as a “standard routine” to accommodate all potential uses of data does not appear to be a very cost effective or attractive approach and a more flexible, multi-tiered system needs to be considered. It is also worth noting that, generally speaking, the more the level of sub-categorisation, the wider the confidence intervals are likely to be in relation to a given number of samples. Such a review over the range of flows (that need assessment to provide data of national interest) should inform any decision for providing guidance/standards for categorisation, but should also consider the likely implications for statistical robustness.

7.2.2 Standardisation of sampling strategies

In terms of sampling strategies, the most urgent issue highlighted in this report relates to sampling strategies for kerbside waste. The most important factor on which kerbsides studies failed to meet our selection criteria (Appendix 3.3.2) was the requirement that the study should have two or more phases: 76% of collated studies failed on this criterion, with this being the only reason for failure in 58% of failed studies. If a greater proportion of local kerbside studies were to include more than one phase in the future, this would be a very significant benefit for future reviews of national municipal waste composition.

The approach to stratification in kerbside studies is more consistent across the collated studies, with many of the studies using ACORN to stratify their samples. However a few studies carried out in county councils have attempted to carry out ACORN stratification at a county council level, rather than a district level; (see Appendix 5.2). Since we can expect the characteristics of different districts within a county council to often be quite distinctive (not least in terms of differing kerbside collection systems in different districts), it is not considered that this approach is suitable for producing district level kerbside compositional estimates. Furthermore, it is recommended that national municipal waste compositional estimates are produced from the district level, insofar as kerbside wastes are concerned. Therefore it would be beneficial for county level kerbside studies to attempt to stratify their samples at district rather than county level, especially since any particular county council will account for several districts, which could then provide a significant amount of kerbside compositional data for future reviews of national municipal waste composition. If contractors were to more openly report on the statistical uncertainties associated with these stratification decisions, then a greater understanding of their shortcomings would be established.

Following on from the last point, contractors appear to have converged on the approximate number and size of sample needed to have a reasonable, if still fairly ill-defined confidence level in the data, based on experience and assessments of large data sets over time, and/or specific studies designed to look at variance. In practice, designing every campaign to permit direct assessment of confidence level in each analysis result requires replicate sampling which inevitably increases costs and is unlikely to be widely adopted in locally funded campaigns, where the need for coverage rather than depth tends to dominate client thinking.

This makes the case for some pragmatic thinking about what is needed at national level where large numbers of locally produced data sets can be accumulated and subjected to a range of statistical analysis techniques, including random/stratified selected subsets to inform confidence levels. Essentially the key requirement is to know that the individual analyses represent what they

claim to represent. In the first place, where there are departures from random sampling or stratified random sampling, a view needs to be taken about potential to bias the result.

At the level of taking increments for the sample analysed, departure from true random sampling, such as taking every 10th household in a catchment area or person arriving at a bring site is very unlikely to lead to significant bias. However, if nearly all samples analysed are taken in the morning (as appears to be the norm for some HWRC analyses) advice must be given to practitioners to abandon this practice or demonstrate by a focussed campaign that bias does not occur. This is not an issue with collected waste as whether collected morning, afternoon or night, it represents 1 to 4 weeks' waste generation for that household; but for HWRC waste it is entirely conceivable that afternoon samples would report a higher garden waste content than morning samples with a resulting bias that subsequent statistical testing will not identify.

Where stratified sampling occurs, i.e. by socio-demographic or housing type for collected wastes, the potential benefits would only be fully realised at national level if the practice is widely adopted and adopted in a consistent manner, through using the same clustering method (i.e. ACORN) or definitions of property type.

Furthermore while there are real practical benefits of adopting a stratified approach using such classifications at a local level, this is usually because other major factors affecting composition and weight arisings are constrained, such as samples taken in same time period, waste management infrastructure and management methods are common across the authority, etc. These benefits tend to disappear at higher levels of aggregation or when attempts are made to apply these data to a different authority or area due to the fact that these other influencing factors differ and their affect on the waste flows cannot be predicted.

Also it may be inappropriate or very problematic to adopt a particular stratification technique that works for one flow (i.e. residual waste from individual households) to other waste streams (i.e. most bring systems) or other points in the waste management system (i.e. inputs to an EfW plant). Stratified sampling should be viewed primarily as an approach to overcome the many practical issues faced by a fully randomised design.

Fully random sampling at household level for an authority would require individual collection of householders spread across the whole authority and could never be accomplished over a single day because waste collection days differ. Adopting a stratified approach within an area can overcome such problems without seriously biasing the results, provided other known key influencing factors are controlled / accommodated.

7.2.3 Mechanisms for increasing standardisation

In this Appendix we consider the relative merits and demerits of encouraging or enforcing standardisation of waste auditing protocols through, respectively, guidance or standards. By guidance we refer to recommendations from “policy” centres such as Defra or SEPA, regardless of whether these are actually termed guidance or standards. By “standards” we refer to methodologies set out by the national or international standard bodies such as British Standards (BS), AFNOR, EN, ISO, etc.

Existing guidance in England is confined to household waste and was issued in 2004² (Defra 2004). SEPA have issued national methodology document³ which sets out the recommended primary and second tier category definitions and approaches to sample selection, phasing and analysis. It mainly addresses collected household waste streams; but notes that the category definitions at primary level need to be used and the underlying sampling / analysis principles recommended will be relevant to other household waste streams. The Welsh Assembly Government⁴ (Welsh Assembly Government 2003) study on municipal waste composition is, *de facto*, the guidance methodology that is recommended for studies in Wales but was clearly

² Defra 2004: Waste composition analysis, a guide for local authorities.

³ SEPA 2008: National methodology for household waste composition analysis in Scotland

⁴ Welsh Office 2003; The Composition of municipal solid waste in Wales

adopted as part of a national sampling exercise, rather than as advice for specific local campaigns. There are no BS standards covering sampling and category compositional analysis protocols for household waste but other countries, (i.e. the MODECOM system in France) have taken this route. There are numerous national and international standards for analysing waste materials for chemical composition and bulk properties such as moisture, ash, calorific value; though the initial sample extraction method stage may not be covered or only defined for a narrow set of waste types/flow conditions (i.e. Solid Recovered Fuel of a certain size / nature, bales of plastic, sampling from a vehicle, etc).

Although both guidance, as well as BS type standards, can always be ignored in a local campaign, it could be argued that the “comfort factor” associated with stating results obtained using a recognised standard carries greater weight. However national policy bodies have many levers to promote wide adoption of guidance should they choose to apply them, though evidence from this study suggests many local data gathering exercises in England have not followed the categorisation definition suggested; nor the phasing to accommodate seasonality recommended by Defra in its 2004 guidance.

Despite this observation, there are constraints on the scope and type of coverage appropriate for a conventional standard. Issuing bodies are (rightly) concerned that only matters of fact, proven scientific techniques and statistically valid methods are appropriate subjects for standards. This also usually means the standard only pertains if very specific conditions are met. Guidance on the other hand can take a more pragmatic view where uncertainty exists and the “greater good” of recommending practical, cost effective practices to stimulate use and hence generation of consistent data outweighs the theoretical purity of methods that might be considered more intrinsically sound.

Given the complexity and problems associated with sampling the diverse flows that constitute municipal waste and the large range of potential end uses of the data, guidance rather than looking to develop new standards in this area is probably a more productive approach; certainly in the short-term. The involvement of a suitable range of stakeholders in the production of such guidance - including central government, local authorities and waste audit practitioners – will assist in arriving at practical standards and obtaining buy in from these stakeholders.

The issue remains as to how to encourage practitioners to adopt such guidance. One highly effective measure would be to make the adoption of this guidance a condition for any central government funding support for local waste auditing campaigns (see Appendix 7.4). However if recent trends continue, a proportion of future local campaigns will be funded solely by local authorities. In this context it is recommended that this guidance is assertively and proactively promoted through an appropriate range of fora; for example, in England: LARAC, NAWDO, LGA and CIWM.

7.3 Investigations of variability in municipal waste composition

The guidance on waste auditing protocols suggested in Appendix 7.2 above will inevitably rely on a number of assumptions. This does, however mean that the recommending bodies should take on board the implications of balancing theoretical rigor with pragmatism. There is a case for arguing that the recommending bodies should undertake the work necessary to demonstrate that impacts of adopting the assumptions underlying the guidance are negligible on the accuracy required; or that any systematic bias is identified and accommodated subsequently. These issues are essentially centred around the variability in composition and arisings of specific aspects of municipal wastes.

It is therefore recommended that the validity of those assumptions which are most likely to affect the robustness of compositional data from waste auditing are investigated through specific research projects. A practical example of this would be SEPA’s advice⁵ that the post-Christmas period should always be avoided in campaigns to generate waste composition data. From a

⁵ SEPA 2008: National methodology for household waste composition analysis in Scotland

resource and cost perspective, any particular authority is clearly going to get a more representative result from the 2 or 4 samples taken in a year if it does avoid the unusual Christmas period. However, in this example it is arguably a case for carrying out sampling Christmas waste on behalf of all local authorities to better understand the impact of this advice on the “national” average: an aspect that was included in the 2003 Welsh Assembly Government report.

The key assumptions which have been identified by this project which are recommended for further investigation include:

- the degree to which the use of ACORN groups is a suitable method for stratifying kerbside samples at a district level, and whether an alternative approach would be more appropriate, whilst being practicable (see Appendix 5.2);
- further assessment of the validity and robustness of sampling strategies typically employed in waste audits of various municipal waste streams, in terms of numbers and weights of samples;
- assessment of composition of “black bag” wastes at HWRCs to assess the degree to which these wastes are similar to kerbside wastes in the catchments of the relevant HWRCs;
- whether the composition of HWRC samples taken during morning periods differ from afternoon periods (see Appendix 5.3).

7.4 Funding support for local waste auditing campaigns

Challenging recycling targets for local authorities in the UK means that it is likely that the recent demand for local waste auditing campaigns is likely to continue. However it is important to note that whilst coverage for English kerbside and HWRC wastes is good, there are currently significant gaps in municipal waste compositional evidence, (see Appendix 6). In view of this, it is suggested that there is a case for central government to provide funding support to local authorities to carry out waste audit campaigns that address these gaps. Any such support should be on the condition that standardised waste audit protocols are adopted (Appendix 7.2).

The most significant data gaps relate to the Devolved Administrations, and it is suggested that funding support may be required, as follows:

- Scotland: kerbside residual, multi-phase and stratified studies; HWRC residual studies.
- Wales: update of the 2003 study; or multi-phase and stratified kerbside residual studies, and HWRC residual studies.
- Northern Ireland: update of recent national review, to include more Northern Ireland authorities; multi-phase and stratified kerbside residual studies, and HWRC residual studies.

In terms of coverage in England, it is worth noting that although coverage for HWRC wastes is good, there is a bias towards more affluent authorities. Providing funding support studies of HWRC wastes in several less affluent authorities would address this imbalance.

As noted in Appendix 6.3, there are significant data gaps for non-kerbside and non-HWRC waste streams. All of these streams merit investigation, if necessary through campaigns wholly or partly funded by central government, though data gaps for some waste streams are more important than others, primarily due to the tonnages represented by the various waste streams. The main non-kerbside and non-HWRC waste streams requiring investigation, in order of priority, are as follows:

- Non-household residual waste (i.e. commercial waste collections carried out by local authorities);
- Street cleansing, sweepings and litter;
- Bulky waste collections;
- Non-household recycling (commercial waste recycling collections provided by local authorities).

7.5 WasteDataFlow categorisation of recycling tonnages

Significant uncertainties have arisen in the waste composition estimates for England presented in this report due to the reporting of some WasteDataFlow tonnages under broad categories that encompass more than one material, as discussed in Appendix 4.4. These uncertainties also affect estimations of the biodegradable content of municipal waste. The most significant data gap relates to WDF's *co-mingled materials* category for kerbside recycling tonnages, which accounted for about 1.2 million tonnes in England during 2006/07. Our analysis of kerbside recycling WDF tonnages shows that many authorities where recycling is sorted at the kerbside report a single figure for all materials collected under this category (see Appendix 4.3.1.2). The robustness of municipal waste compositional estimates for these authorities would be considerably improved if they were to report separate tonnages for the various materials that are collected and sorted at the kerbside (glass, metal cans, paper, etc).

Other authorities collected co-mingled recycling at the kerbside and therefore presumably have no choice other than to report a single tonnage figure under WDF's *co-mingled materials* category. It would be beneficial for these authorities to report which materials are targeted by their co-mingled kerbside recycling collections. This would assist in producing estimates of the breakdown of composition of the *co-mingled materials* tonnages for these authorities. However we consider that there is currently insufficient reference data for reliably determining the breakdown composition of co-mingled kerbside dry recycling, even when a list of targeted materials is known. Moreover, little is known about the variability in composition for different co-mingled kerbside dry recycling systems which target similar ranges of materials.

WDF includes an '*other*' category for HWRC recycling which is problematic, accounting for over half a million tonnes of material in England in 2006/07. In this study we estimated that much of this material consists of wood (see Appendix 4.3.2.2); however our estimates are uncertain and rely on limited reference data. It would therefore be beneficial if several recycling categories could be introduced for WDF HWRC recycling:

- Wood
- WEEE (excluding white goods)
- Furniture
- Hazardous.

It would also be helpful for WDF to include separate HWRC recycling categories for scrap metal and white goods. These materials are currently included under a single *Scrap & White goods* category, making it difficult to determine the proportion of white goods (much of which will be WEEE) in HWRC recycling.

Other problematic categories in WDF relate to household recycling by "Other means" and non-household recycling, where no breakdown of tonnages by materials is provided. It would be beneficial for WDF to be set up such that local authorities can report separate tonnages by material types, particularly in relation to non-household recycling, which accounted for over 200,000 tonnes of material in England during 2006/07.

7.6 Further analysis of data collated by this study

The datasets collated during this project could be further analysed to provide additional useful compositional evidence. For example, due to the large quantity of data collated it has been beyond the scope of this project to analyse waste components a more detailed level of categorisation than the primary categories used in Appendix 4. The subanalysis of plastics arising in kerbside wastes presented in Appendix 2 provides an indication of type of compositional evidence which is currently embedded in the collated data, but which this project has not had the opportunity to analyse. Furthermore, many of the collated datasets include subsamples, such as compositional data for separate ACORN groups, and it is possible that analysing compositional data may throw light on issues relating to stratification and sampling approaches to the auditing of kerbside wastes. Additional comments on potential further analyses of collated data are provided in Appendix 10.