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WASTE COMPOSITION ANALYSIS

Guidance for Local Authorities

Project Partners:

Entec

defra

WASTE COMPOSITION ANALYSIS

GUIDANCE FOR LOCAL AUTHORITIES 2004

Produced on behalf of
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Foreword

Over the past decade the growing pressures to better manage our waste have meant that waste analyses are evolving to become an increasingly important tool for local authorities. They can potentially provide valuable data to assist with waste management research, planning and operations. However, there remains a degree of confusion about what a waste analysis will deliver and how it is best executed. There are also issues surrounding the comparability of different datasets as a result of a number of factors - mainly different methodologies, classifications, and statistical validity.

This guide is a timely resource for waste managers seeking to better understand the main issues in relation to waste composition - from the initial questions that need answering, through to procurement or prior to execution of a study. The ultimate aim of the document is assist in the development of improved waste management practices.

There have been a number of recent key waste composition publications, namely the Strategy Unit Report, the Welsh Assembly National Composition Study, and the SWAT Precision and Compatibility Study. A number of other major studies are also proposed - not least the Environment Agency National Household Survey and SEPA (Scottish Environment Protection Agency) National Survey.

In light of recently evolved National Targets (including those derived from European Directives such as the Landfill Directive), we need to learn more about what is in our waste. This document is not intended to provide a protocol for waste composition in England, or to endorse any particular approach. Instead, it aims to provide those wanting to learn more about waste composition with an overview of what waste composition analysis is and the issues involved, as well as acting as a sign-posting document to other more detailed information if required.

Contents

1. Introduction

1.1 Purpose of this Guide

This guide is designed primarily to assist local authority officers to develop a better understanding of waste composition analysis. It provides guidance on the types of information a waste analysis can and cannot provide, how an analysis links to other waste data, how to interpret and make use of waste analysis data, and finally, how to specify a waste analysis that will deliver the data required. Although waste composition data may initially appear straightforward, there are many pitfalls in obtaining and using such data. If these are not recognised and subsequently avoided, the data obtained could be virtually useless, or worse - misleading.

This guide sets out the fundamental principles for ensuring that good quality data is obtained and utilised appropriately. It is not a comprehensive operational manual for conducting a waste analysis and as such no single methodology or set of methodologies are recommended. For the purposes of this document, the waste composition analysis methodologies discussed are intended to relate primarily to the household waste stream (refer Box 1 for a description of household waste), although the principles involved should remain valid for other waste streams.

1.2 What is a Waste Composition Analysis?

A waste composition analysis provides information on the materials that are in a given waste stream. Analyses are most commonly conducted on the residual waste elements, such as household collected bag or bin waste. It is also possible (and often desirable) to conduct analyses on material arising from other household waste streams, such as collected recycling or Civic Amenity site waste. The advantages and disadvantages of looking at these different waste streams are discussed in Section 2.

1.3 What Can it Tell Me?

Like any data gathering exercise, a waste analysis will tell you as much or as little as the design allows, but the most common types of information produced include:

- The range of materials or objects in your waste
- The amount of each of these materials and their relative proportions in your waste
- How much each household throws out
- Where the material is coming from. For example, by geography, housing type, socio-demographics, facilities, vehicle type, etc.
- How much of each material or object households or businesses recycle, compared to how much they throw out (i.e. recognition and capture rates)
- Differences in waste composition between different periods of time, such as different seasons, or different times of the week
- Possible trends – such as whether materials being measured are increasing or decreasing in the waste

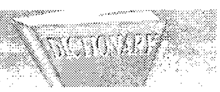
As can be seen there are a number of different reasons why a waste composition analysis may be conducted. However, before conducting any analysis, it is important to have a clear focus on the different questions that need answering and to ensure that these are incorporated into the survey design. Ideally, a waste composition analysis should sit as part of a wider research programme. Linking different research elements such as compositional analyses, questionnaire surveys, and observational and participation surveys will provide more complete and more useful information than conducting each research project independently.

1.4 Structure of the Guide

This guide is set out in two parts: the main body of the guide provides an overview of the key elements of waste analyses. In addition to this, a set of appendices provide more technical detail on the various components of waste analyses. Readers are referred to relevant appendices throughout the main document. This enables the guide to be used as both a general guide and a reference tool.

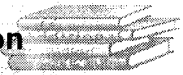
The final appendix is a signposting section to direct readers towards key published references on specific topic areas discussed within the document.

Annotated boxes divided into the functions below are used throughout the document to highlight key issues, and to provide additional detail for quick reference.

Definitions 

Useful Tips

Questions & Answers

Additional Information 

Definitions: Household Waste v Municipal Solid Waste

Box 1

Household Waste

Local authorities have a statutory responsibility for managing household waste under the Environmental Protection Act 1990 Section 45(1), and have to meet Best Value Recycling and Composting Targets for household waste. Household waste is comprised of a number of waste streams (Figure 1.1).

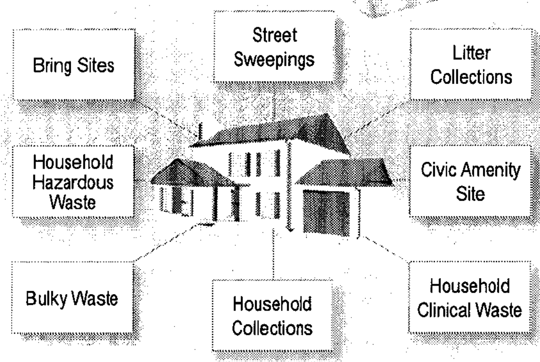


Figure 1.1 Household Waste Sources

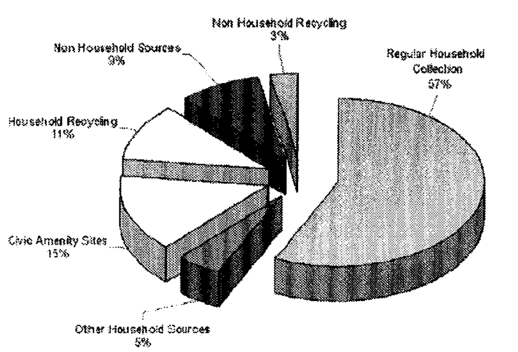
"Household Waste" is all waste collected by Waste Collection Authorities (WCA's) under Section 45(1) of the Environmental Protection Act 1990), plus all waste arisings from Civic Amenity (CA) Sites and waste collected by third parties for which collection or disposal recycling credits are paid under Section 52 of the Environmental Protection Act 1990."

Municipal Solid Waste (MSW)

Municipal Solid Waste (MSW) includes all household waste, plus commercial waste and recycling that is managed by the council, parks and gardens waste, non-household clinical waste, cleared fly tips and a number of other minor categories of waste managed by the council. It does not include commercial waste and recycling collected through arrangements with private contractors.

MSW is of key importance to local authorities due to their requirement to meet Landfill Directive targets for the amount of Biodegradable Municipal Waste (BMW) sent to landfill. Local authorities have a requirement to have reduced the amount of BMW sent to landfill to 75% of 1995 levels by 2010, 50% by 2013, and 35% by 2020. This requirement will also have to be met from 2005 through the Landfill Allowance Trading Scheme (LATS) – a system of tradable allowances for the disposal of MSW.

Figure 1.2 Municipal Waste Arisings in England 2001/02 (by weight)



Defra, 2002

Additional Information: National Waste Composition

Box 2

The last national study in England was the study conducted by the Environment Agency in 1997, (Parfitt et al 1997). Prior to this was the National Household Waste Analysis Programme (NHWAP) undertaken by the former Warren Spring Laboratory in 1994 for the Department of the Environment (DoE). No formal detailed national hand sorting study has been undertaken in England since then, although there are plans for the Environment Agency to conduct a national survey in the near future. The Welsh Assembly have undertaken a National Survey, which is briefly discussed later in the document (refer box 25, ch6).

Table 1.1 Strategy Unit Waste Composition in England 2000/01

Category	Bin Waste[1] (Wt)		CA Site Waste[2] (Wt)	
	%	Kgs per hh per year	%	Kgs per hh per year
Newspapers and Magazines	8.1	71	1.3	3
Other Recyclable Paper	5.8	51	0.9	2
Liquid Cartons	0.4	4	0.0	0
Board Packaging	1.2	11	1.6	4
Card and Paper Packaging	3.5	31	0.0	0
Other Card	0.2	1	0.1	0
Non-recyclable Paper	3.5	30	0.3	1
Plastic Bottles	2.1	18	0.1	0
Other Dense Plastic Packaging	2.1	19	0.2	0
Other Dense Plastic	0.6	5	0.6	2
Plastic Film	4.0	35	0.3	1
Textiles	3.2	28	2.0	5
Glass Jars and Bottles	7.9	69	1.2	3
Other Glass	0.5	4	0.2	1
Wood	2.7	24	8.8	23
Furniture	0.3	2	4.6	12
Disposable Nappies	2.4	21	0.0	0
Other Miscellaneous Combustibles	0.6	5	2.3	6
Miscellaneous Non-Combustibles	2.1	18	15.0	39
Metal Cans & Foil	3.4	29	0.0	0
Other Non-ferrous Metals	0.0	0	0.1	0
Scrap metal / white goods	2.9	26	9.7	25
Batteries	0.0	0	0.2	1
Engine Oil	0.0	0	0.1	0
Garden Waste	15.3	134	37.6	98
Soil & Other Organic Waste	1.1	10	11.3	30
Kitchen Waste	12.1	106	0.3	1
Non-home Compostable Kitchen Waste	10.1	88	0.0	0
Fines	3.7	32	0.9	2
TOTAL	100.0	872	100.0	261

Source: Parfitt 2002.

1 'Bin Waste' refers to residuals + kerbside recycling and non-CA bring recycling

2 'CA Site Waste' refers to total Civic Amenity residuals + recycling (excluding building rubble)

2. Setting the Objectives

2.1 Introduction

The most crucial step in the waste analysis process is deciding why you are undertaking a waste analysis and what you will use the information for. It is vital that this is clear to everybody involved before undertaking any survey. Establishing a clear set of objectives will help ensure that you get both value for money and that the survey produces information that meets your waste data needs.

2.2 Why Should I Do a Waste Analysis?

There are a number of reasons why you may consider undertaking a waste analysis. Perhaps one of the most beneficial reasons, at a local level, is to understand and evaluate the performance of a new or existing service. For example:

- **Monitoring and Improving Existing Recycling Schemes.** A waste analysis will allow you to calculate the amount of each targeted material captured, and identify which materials are remaining in the residual waste. This will provide more accurate information on how residents are behaving, so that information and education campaigns can focus on poorly captured materials or address other issues such as contamination.
- **Developing and Implementing New Recycling or Composting Schemes.** Waste composition data may be crucial for predicting how a new scheme will perform and how much material can practically be recovered. The suitability of different areas for a given scheme may be identified during this process.

Other reasons could include (but are not restricted to) the following:

- **Developing a Waste Strategy.** Waste strategies address how a resource will be managed. Therefore, understanding the composition of this resource may assist the decision making process and facilitate projections regarding progress towards meeting recycling targets, LATS allowances and the impact of different strategy options.
- **Benchmarking Against Other Areas.** Waste analysis data allows you to benchmark against national averages and neighbouring authorities or authorities with similar demographic or economic profiles.
- **Examining Waste Arising Data.** For example operational data may suggest that your annual arisings are increasing by around 3%. A sustained waste analysis will help to identify the main drivers behind this change, highlighting if all materials are increasing at the same rate, or if the change is a result of one or more specific materials being disposed of.
- **Research and Waste Databases.** Waste analyses can form part of a sustained research programme to monitor disposal and recycling behaviour so that trends can be analysed.
- **Public Education.** Data from waste analyses can be used to support local issues such as education programmes and campaigns, or to promote an initiative or strategy to stakeholders.

2.3 Which Waste Streams Should I Try To Get Information For?

Figure 2.1 illustrates the different types of household waste streams found in most local authorities and their approximate proportions. Most authorities that undertake waste composition analyses examine a combined sample of kerbside residual and recycling. An increasing number of authorities are also analysing their CA site waste. These are two of the most common streams to look at, as together they normally account for the majority of household waste. However, you should make sure that this type of analysis alone would provide the data you need. For example, if you need accurate information on the total household waste composition, then just sampling one or two of the nine streams may give you an indication, but it will not give you the full picture.

2.4 What Will I Use the Information For?

A waste composition survey is normally designed to answer a specific set of questions that are identified prior to commencing the survey. Once the data has been obtained, and the potential value of the data recognised, a very common error is to extrapolate this data and attempt to use it for different purposes

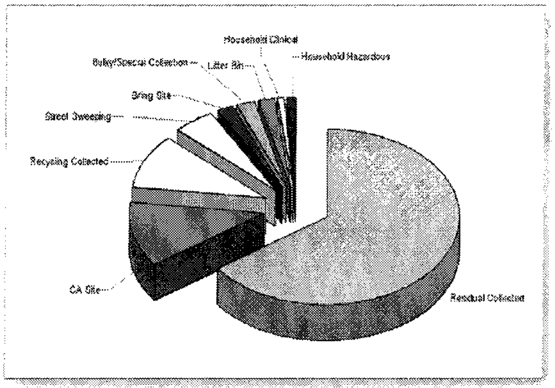


Figure 2.1 Typical breakdown of household waste

than it was originally collected for. Although the same waste composition data can be used for a number of different purposes, it is critical that this is decided at the outset and incorporated into the initial research design. If not, data may be gathered in such a way as to make it difficult or invalid to apply to other uses. For example, if you decide to do a 'bulk analysis' (refer Table 5.1 Common Sort and Weigh Techniques and Their Relative Merits), which will provide a total figure for the composition of household collected waste, this can not then be used to find information on the distribution of bag/bin weights per household at a later stage.

2.5 How Does a Waste Analysis Fit With Other Waste Data?

The following issues should be considered:

Will it be compatible with national data?

Gathering information in a way that is compatible with national data has a number of advantages. The information will be able to contribute to national databases and improve the quality of decision-making and it will be possible to accurately compare your performance with national averages. If certain datasets are unavailable, it may be appropriate to use national data to supplement your own information.

Box 3

Useful Tips

If you only sample household collected waste, be careful not to extrapolate this to other waste streams or to the household waste stream as a whole.

However, it is important to emphasise that the most recent data should be used, wherever possible. For example, references to NHWAP data, collated in 1994, may soon become limited in that the composition of waste (especially the residual fraction) is likely to have changed in relation to a number of factors (see chapter 4), alongside the rapid implementation of kerbside recycling schemes.

Will it be compatible with data from neighbouring authorities?

Sharing data with neighbouring authorities (particularly those in the same Waste Disposal Authority catchments) can have advantages for benchmarking performance, supplementing datasets and improving data quality, providing the information has been gathered in a similar manner.

Will it be compatible with data held on other parts of the waste stream, particularly operational data?

It should be possible to make full use of your own data and not have to undergo complex consolidations or analysis to build up a useful picture of your own area.

Consideration should be given to your operational data. This includes all data obtained in the course of managing and monitoring your existing services. For example: tonnages collected for each of the different household streams and the amounts of recyclable material a contractor might collect. Depending on the quality of the data, you may have information on total tonnages, breakdowns by time, by round or collection point, or in the case of recyclable materials, the amount of each material and where and when it originated.

Where possible, composition data needs to be compatible with operational data, so that you can add to it if required. For example, if you have accurate annual tonnage information on the amount of material collected, and you know how many households use your service, then results from a sample of household collected waste can be used to project the tonnage of each material type disposed of by each household.

Can it be linked with other data such as participation rate data, trial data or household survey data?

When planning participation or household surveys, it makes sense to ensure that this information is compatible wherever possible. In order to achieve this, your waste composition surveys should be conducted at a household level in the same area, using compatible sample sizes and information that is categorised in a similar fashion and conducted during comparable times of the year. In essence, it is best to integrate your waste composition research with other research data sets to maximise the value of all the information that is obtained.

Participation Survey Data. Box 4

Participation data is useful for determining how many people actually use each of your services. Participation Rate is defined in box 6. If you have good participation and tonnage information, you can determine on average how much households throw out or recycle. Adding composition information allows you to determine which materials are left and where the gaps are in your capture rates, which will allow you to more effectively target programmes to increase capture. For example, are some households recycling well, and others not at all, or are most recycling but not as well as they could?

2.6 What Sort of Waste Analysis Do I Need?

Generally there are four types of primary methodologies used to gather waste composition data:

1. **Physical Sorting and Quantification Type Analyses.** The defining feature of physical sorting and quantification type analyses is that the waste to be sampled is physically separated into a number of classifications (usually predetermined). Each of these classifications are then quantified individually (either by counting or weighing) and the quantities tallied to arrive at a breakdown of the composition of the waste that has been sampled.
2. **Visual Analysis.** In a visual analysis, waste material is not physically separated, but an estimate of the proportions of different components of the waste stream is made based on the amount of each type of material in the sample that can be seen by the auditor. These analyses are often used to detect the presence or absence either of contaminants or of a type of material. E.g. whether there is a lot of paper or not much paper in the waste.
3. **Operational Data Capture.** Operational Data Capture refers to the use of data obtained from monitoring existing operations such as recycling collections or CA site operations. This is the easiest form of data capture, and data from these sources is usually available to all local authorities (although the quality will vary). Information gathered includes; tonnage figures for total amount of material handled and for separately collected materials or material sold to separate markets.
4. **User Survey Data.** User Survey Data simply refers to asking people what they throw out or recycle and how often. This could be via a telephone survey, face to face interview, or questionnaire. This is a common form of data gathering in trials and when reviewing the performance of schemes. One disadvantage with this method is that people have a tendency to 'over report' their use of recycling services. However, this effect can be controlled by linking household survey data to waste data (This again highlights the advantages of having an integrated research strategy).

In addition to these primary types of methodologies there are a number of supplementary techniques that attempt to utilise available primary data in order to make estimates about possible waste composition. Although these techniques have their appropriate uses (refer Table 2.1) it is generally not advisable that they be used as a substitute for obtaining local compositional data. These supplementary techniques include:

1. **Waste Composition Profiling.** This technique involves using data from other waste streams to estimate a probable composition of a waste stream without actually undertaking any sampling from that waste stream. As discussed below, waste composition and arisings can be related to a range of factors including, socio-economic factors, climate, geography and land use, demographics, culture, housing type and the types of waste and recycling services provided. It is possible to determine 'typical' composition profiles for particular groups using one of a variety of tools such as ACORN or MOSAIC. These composition profiles can then be used to try and predict the waste composition of a community without undertaking a physical audit. It should be noted however that the 1994 NHWAP study has since been shown to provide inaccurate data relating to ACORN profiles and caution should be taken when trying to predict composition based on socio-demographic profiles.
2. **Benchmarking**. This involves establishing extensively monitored 'benchmarking areas' with 'representative' profiles. – For example a full set of waste streams from a local authority could be monitored, or if you are concerned with particular streams such as CA wastes, then a CA site could be monitored. Other Local Authorities, for example authorities within the same county or region can then benchmark themselves against this data, and use this to control for such things as seasonal variations, and changes over time. This may be an option for Local Authorities to reduce the frequency (and hence cost) of waste analyses, whilst providing some ability to adjust local data to larger and long-term trends.
3. **Input / Output Based Data Analysis**. A material input survey simply looks at material that is purchased over a given timeframe. It assumes an average flow of these materials through the community, to arrive at an estimate of what is being disposed of. An input - output survey goes one step further and attempts to match up inputs with known outputs, while allowing for system losses. These types of techniques are most commonly applied to situations with finite controlled inputs and outputs – such as with commercial or industrial processes, or to specific materials within the waste stream such as

Box 5

Question & Answer

Q Which is the best method ?

A The short answer is that he best method is the one that best delivers the research objectives at the lowest cost. Each technique is suited to gathering a particular type of information, so it depends on the information you wish to gather. Appendix 1 provides a case study of an analysis of a CA site, which illustrates some of the considerations involved in deciding on the approach to be used for the analysis.

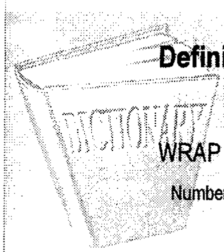
packaging materials, which have a measurable average time of residence in the system before being discarded. Generally, this is not a valuable technique in relation to waste data at a local level as inputs and outputs are not known, and data is difficult to obtain. This technique is usually only applied to waste data at a national level with any degree of accuracy.

As well as applying the above techniques separately, they can sometimes be used together in an integrated survey design to improve the quality of the data obtained. For example a CA site analysis may combine physical quantification and analysis for the majority of vehicle loads sampled, with a visual survey of large homogenous or relatively homogenous loads, and operational (weighbridge) data to obtain actual weights for the visually surveyed loads. Such a technique would mean more loads could be assessed than by physical quantification alone, improving the reliability of the information obtained.

Table 2.1 gives an idea of some of the uses, and advantages and disadvantages, of each of these techniques. Although several different techniques are outlined here (with many variations possible on each), by far the most common technique used in the UK for waste composition analysis is Physical Sorting and Quantification. This is potentially the most accurate method when determining residual composition, particularly if detailed information about the materials in the waste stream is required. The vast majority of data available relates to information gathered using this technique (refer to Appendix 6) As a result of this, the remainder of this guide focuses on issues particularly related to the physical sorting and quantification methods. However, where specific issues to other methods arise, these are clearly noted in the text or appendices.

Box 6

Definitions: Participation Rate



WRAP calculate participation as:

Number of households putting out a container at least once per month

Divided by

Number of households served

If the scheme collection frequency is fortnightly then the period in which participation is measured is six weeks

Box 7

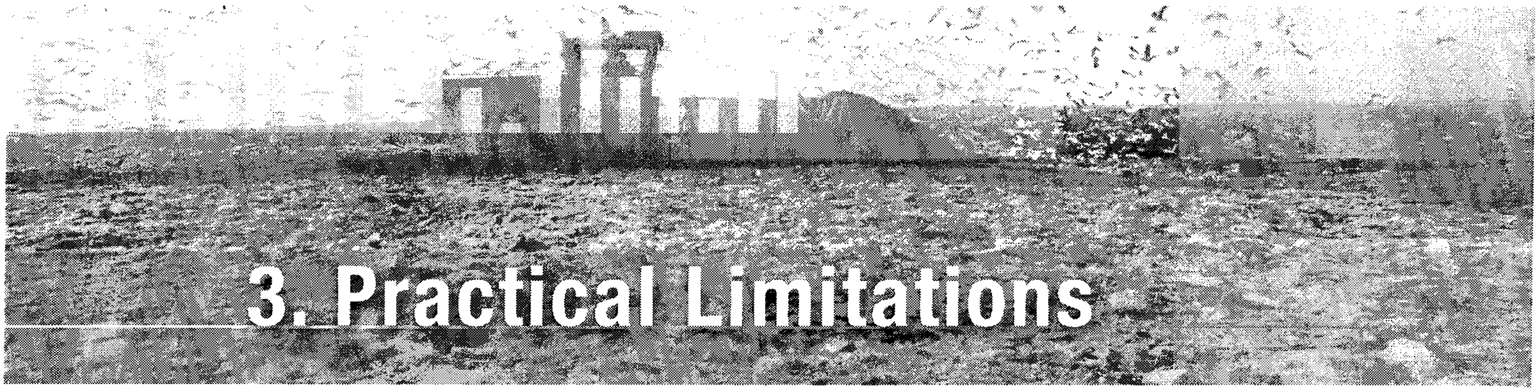
Checklist of questions to be asked:

- Do I want to improve an existing recycling scheme? ○
- Do I want to introduce a new scheme? ○
- Do I want to develop and inform a waste strategy? ○
- Do I want to compare my data with other areas or local authorities? ○
- Do I want to monitor existing refuse and recycling schemes? ○
- Do I want to gather information to help solve a problem? ○
- Will this fit with other information I have? ○
- Is this the best use of my money and resources? ○
- Do I have the time, money and resources available to do the survey I need? ○
- Do I need to develop a research database? ○
- Do I need to evaluate the effect of a waste education programme or campaign? ○

Table 2.1 Advantages disadvantages of waste analysis techniques

	Useful for	Advantages	Disadvantages
Physical Sorting and Quantification	• Household collected waste • Recycling surveys • Bring site surveys • CA site surveys • Litter surveys	• Precise measurement of materials and samples is possible • The mass of material being measured does not change under compaction and so is more consistent • Physical separation of the waste allows accurate identification of the constituents of the waste stream • Well developed procedures and systems are in place • A large amount of data has been gathered on a sort and weigh basis, enabling historical and geographical comparisons to be made	• Time consuming (and therefore relatively expensive) • Because of the time and costs involved, only relatively small and infrequent samples are usually possible. This means these surveys tend to be a snapshot in time and therefore not representative of a waste stream for an entire year or authority This also means that, although the make up of the samples are precisely determined, the number of samples that can be taken is relatively low and so hence the overall precision of the data that can be obtained may be compromised (if there is a high degree of variation among the population). • Health and safety issues associated with the handling of waste
Visual	• Bulky waste surveys • CA site surveys (particularly involving bulky loads) • Surveys where only indicative data is required. • Bring site surveys • Litter surveys	• Analysis of a large number of samples is possible within a given timeframe. This means that a larger number of samples can be taken enabling a higher overall level of precision for a survey • The primary components of the waste stream can be accurately identified • Low levels of health and safety risk	• A lack of precision in identification of lesser components of the waste stream. • Inconsistencies between individuals undertaking visual analyses. • Compaction (or lack of it) can alter the apparent volume of the material being surveyed and so alter the estimated proportion in the sample. In relatively homogeneous streams, hard or dense materials that do not alter significantly under compaction are therefore easier to correctly estimate in visual surveys. In mixed waste streams, the light fractions tend to remain on top and can be overestimated. This is difficult to compensate for, as there is no way to quantify the degree of error. • There are a large number of different factors that can impact the reliability of this type of analysis, meaning it is harder to control for these sources of variation.
Operational	• Residual collection tonnages • Recycling collection tonnages and material breakdowns • Bring site collection tonnages and material breakdowns • CA site collection tonnages and material breakdowns • Litter collection tonnages	• Data obtained is actual values, not estimates • Regular, ongoing data is available • Data gathering and recording methods can be tailored to obtain the desired information • Historical data is usually available or can be built up to determine long term trends • No additional surveys are required to obtain the information.	• Because the information is gathered for operational purposes it does not always suit the needs of council. For example material collected from kerbside collection rounds and bring sites may be consolidated by the operator before being sold. This would mean that sales data would be for material from the different collection streams and could relate to different time periods over which it is collected. By way of further example if you operate a source segregation scheme, you may be able to obtain information on the market outlet (e.g. how much mixed paper), but this does not provide detailed information on the actual material being collected. This data is therefore limited, and without composition data it will be hard to accurately identify potential for improvement. • Historical data can be subject to changes in how it is gathered that makes identifying long term changes problematic. • The data is limited to what can be measured by ongoing operations, and will not for example contain information about the composition of the residual components, or measures of arisings from people using the schemes.

	Useful for	Advantages	Disadvantages
User survey	• Determining participation rates • Monitoring trials • Gathering household perception information	• Insights into householder/user behaviour can be gained • Can be added to other quantitative data to build up a more complete picture • May reveal levels of user satisfaction, reasons for lack of participation, problems with system, possible improvements etc	• Self report data is generally not considered to be accurate • Questions and interview methods can bias results • Limited ability to gather quantitative data
Waste composition profiling	• Household waste surveys • Recycling surveys • Bring site surveys • CA site surveys	• No physical sampling is necessary • Quick and therefore relatively inexpensive (provided that all the profile data has been gathered) • A wide range of predictions may be possible depending on the quality and scope of the profile data • Data will be reported in formats that will enable comparison with other localities • There are no health and safety issues associated with the handling of waste	• It is not possible to establish how accurate a waste composition profile actually is without undertaking a survey to gather primary data. Any calibration of the profile data will always be relative to actual data from another locality, and so anomalies or unique features of the local data may be overlooked. • It is limited in its ability to track changes over time or determine actual changes in composition arising from alterations to the waste and recycling services available to the community. • Detailed composition information (for example, on the proportion of 'junk mail' or 'pet food cans') is unlikely to be available (and if it is, it is unlikely to be meaningful).
Benchmarking	• Household waste surveys • Recycling surveys • Bring site surveys • CA site surveys • Litter surveys	• Where benchmarking has been established, quality data can be available on a number of sites allowing the influence of particular variables to be determined • Waste analyses can be undertaken with less frequency • The data that has been gathered can enable historical and geographical comparisons to be made	• Establishing and running benchmarking exercises is time consuming (and therefore relatively expensive) • Benchmarking will not obviate the need for Local Authorities to undertake some form of waste analysis
Input /Output Survey	• Determining the amount of specific packaging or objects • Predicting arisings at the national level.	• Specific and accurate consumption data can be obtained • Information about specific objects can be generated, for example with determining the number of batteries or mobile phones in the waste stream	• Calculating the flow of materials can become exceedingly complex because of the variety of inputs that must be tracked and the different lengths of time that materials will reside in a community before being discarded. In addition, some types of system losses are difficult to quantify, for example the net balance of imports and exports of packaging material may be difficult to determine. • The spatial units are inappropriate for local authorities to be able to use this method reliably



3. Practical Limitations

3.1 Introduction

The desire to obtain incredibly detailed and accurate data can often be hindered by (amongst other things), the stark realities of limited budgets, and the amount of time available. This section considers these issues.

3.2 Budget

A more detailed and precise survey will take longer to gather the necessary information and hence will be more expensive. Therefore, a waste analysis will tend be a compromise between what is required and the budget available.

Table 3.1 provides an indication of the time taken to hand sort and quantify samples of mixed household residual waste. These will obviously vary according to a range of factors, which will differ between project teams. The 'law of diminishing returns' will also play a part in the time taken to sort a quantity of waste.

The type of waste sorted will also affect the time taken to sort the sample. For example, hand sorting dry recyclables will generally contain larger particle sizes (e.g. plastic bottles, newspapers), than a residual sort containing smaller particles (e.g. food and garden waste, batteries, etc.), and hence will be quicker to sort. Also, it should be remembered that a 'bag analysis' at a household level, would generally take longer than a 'bulk analysis', due to separate weighing and sorting of individual household samples. As a general rule, a bigger and more complicated sort will cost more money.

Table 3.1 Estimated Sorting Time

Sorting Method	Person Days to Sort	
	5 – 10	12 - 25
Bulk Analysis	1 Tonne	2.5 Tonne
Bulk Analysis (Every n^{th} Household)	100 Bags	250 Bags
Bag analysis (Household Level)	70 Bags	160 bags

It is good practice to work towards developing a programme of audits which have specific budget allocations, and scheduled times for undertaking them. When planning your audit programme, you should consider all the possible initiatives that may be taking place in the coming years (in addition to ongoing operations) and their possible data requirements. It is often easier and cheaper to add to an existing waste analysis exercise than undertake a separate one.

Box 8

Useful Tips

If securing budgets for ongoing waste analyses is problematic and you are procuring a new integrated waste contract, a possible solution is to specify that the contractor is responsible for supplying waste composition analysis data. In the context of a large contract, waste analysis work is a very minor cost, and can be absorbed into these budgets relatively easily. The contractor could be required to use an independent auditing agency that meets council's approval, or a specified methodology in order to ensure the quality of the information supplied. There is however a need to ensure that there is control element, so that you can audit what they have done.

3.3 The Dimension of Time

The dimension of time is a crucial factor when it comes to waste analysis data. Waste production varies over time, and changes can occur on a daily, weekly, monthly, seasonal or yearly basis. The level of effects will also vary according to the waste stream analysed. A sample of waste can only really be said to be valid for the day on which it was taken, as the contents of our waste are constantly changing as our society and habits evolve.

The most obvious variation in the household waste stream relates to the production of garden waste. In the spring and summer months, garden waste production is typically double the winter months, especially in household collected and civic amenity site streams. The peak months can be four to five times higher than the lowest months. Figure 3.1 below shows a typical annual pattern of garden waste recycling, with peaks in May and August and a low in December to February (Note: changing weather patterns can affect the timing and extent of the peaks and troughs). The Environment Agency is undertaking a week on week study which could reveal more about the effects of seasonality on household waste composition and quantities (refer Box 25 Chapter 6 for more information). Garden waste has also been shown to change in terms of composition as well as total quantities in different seasons i.e. branches in spring, grass cuttings during summer and leaves in the autumn.

The time of year an analysis is carried out will have a significant effect on the amount of garden waste found in your waste stream. Other seasonal effects include, types of food waste that appear in the waste stream, and the amount of construction and demolition materials that appear in the waste stream.

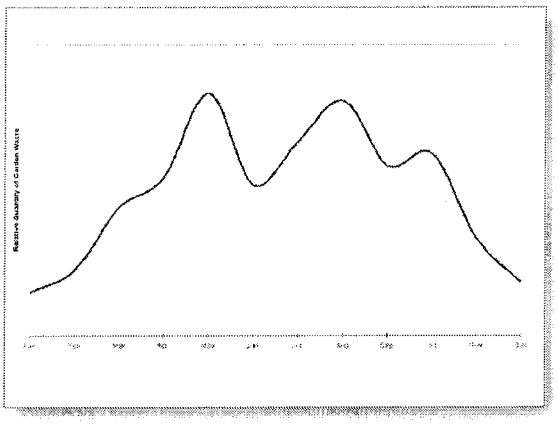


Figure 3.1 Typical annual pattern of garden waste recycling

A common approach to try and take account of these effects is to undertake seasonal audits four times a year. An alternative is to undertake analyses at the mid-points – normally around September and March, and assume that these will give you an 'average' result. However, this may not tell you the level of seasonal variation and it will therefore compromise your data. If immediate budgets or other reasons do not allow for a full seasonal study, then an alternative is to undertake season analyses in the first year to establish a baseline, and to undertake annual or bi-annual analyses in subsequent years. Although the precise timing and impact of the seasonal effects cannot be known in advance, it is a good idea to plan the timing of the audits for practical reasons. Table 3.2 suggests seasonal mid-points which could be used to plan an audit programme.

Table 3.2 Timing of Waste Analysis

	Period			
	Spring	Summer	Autumn	Winter
Ideal Frequency (Every 3 Months	March	June	Sept	Dec
Reduced Frequency (Every 6 Months)	March		Sept	

Adapted from: ERRA 1993

In addition to seasonal effects, there are other changes over time that can influence or bias the data collected.

Waste composition is about understanding what we as individuals throw away or recycle. Logically therefore, what we dispose of is dependent on the activities we are doing at any given time. Our lives are essentially reflected in what we throw away. Circumstances that influence activities outside of our routine lives or that occur a particular time of year will be reflected in the waste streams. The level of effect will be dependent on the type of study undertaken and the type of waste stream being analysed. For example, the days of the week alter the composition at CA sites, but dustbin waste sorts collect a whole weeks waste and therefore the effect is absorbed within the sample collected. Other possible factors that may influence composition, and hence should be recognised when planning the timing or interpreting the results from a survey, are presented below.

Weather – Within the larger pattern of seasons, weather can have similar types of short-term effects. Waste can get wet when it is stored or collected and this makes absorbent items heavier thus making it seem like there is more of it. In addition, different activities typically take place according to the weather, for example people undertake more indoor activities in bad weather and are outdoors or away from home more in good weather. Also, home decorating, spring cleaning, moving house etc all tend to happen with greater frequency in the summer and this will affect the household waste composition.

Days of the week. People tend to undertake more gardening and renovating projects, and entertaining at the weekends, which may affect the waste composition. More materials from these pursuits are likely to be found at CA sites or on bulky waste collections during this period.

Special events. A special event such as Easter, Bonfire Night, New Year, a local or national sporting event - such as the Rugby World Cup can all generate temporary increases in the amount of different materials that people use and hence throw out (or recycle). For example more packaging is disposed of at these times.

Christmas. A large amount of consumption takes place over the Christmas period, particularly of materials that would not normally be consumed to these high levels e.g. packaging, drink containers, wine bottles, Christmas trees and paper!

Other Holiday periods. In some areas a large proportion of the population leave during holiday periods. Surveys during these periods may show lower levels of waste generation. Composition may also be distorted as some proportions of the population are more likely to go on holiday than others – e.g. older, economically disadvantaged, and young families with babies are all less likely to go on extended holidays than other sectors of the population. In other areas the reverse happens as holiday destinations undergo a population explosion over relatively short periods of the year. Much of this increase will be in commercial streams such as restaurants and accommodation. Both areas may show unrepresentative composition if not accounted for in the research design.

Waste analyses should be avoided during these 'anomalous' periods, unless the research is to specifically look at these effects on a particular waste stream. If this is not possible, it should be made clear in both the report and interpretation of the results.

3.4 Realism of Expectations

Waste composition analysis is not an exact science, as it deals with the outputs of (relatively) unpredictable human beings. A waste analysis is unlikely to produce perfectly accurate predictions regardless of the approach taken. If for example, your main aim is to determine whether the amount of cardboard in your waste stream is either precisely 10% or 12%, there is little point in undertaking an analysis, because a waste analysis will probably never give you that degree of certainty or consistency.

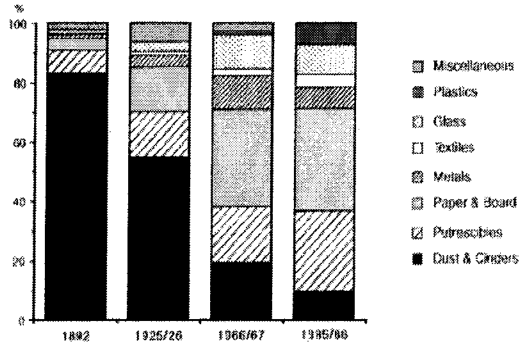
Box 9

Question & Answer

Q Is doing a waste analysis the best use of my budget?

A When evaluating the allocation of budgets, you should think about a waste composition analysis in the context of your overall data needs. Obtaining good quality waste composition data - although potentially extremely useful, can be relatively expensive compared to other ways that you may be able to improve your data overall. If data on the operational aspects of your waste management programmes are unreliable or not sufficiently comprehensive, it may be a greater priority to improve this data before commissioning a waste composition analysis. This will then make your waste composition data more useful when you undertake an analysis.

Longer Time Periods Box 10



Source: Waste Watch (2002)

As the above figure shows, the composition of waste has changed dramatically over the last 100 years or so, with a decrease in the amount of ash and a rise in plastic, paper, and putrescibles. The composition of waste is likely to continue to change in the future, as more materials are recycled and as consumer habits change.

4. Meeting the Objectives

4.1 General

This section looks at the key factors that need to be considered in designing a survey that will meet the objectives you have decided upon.

4.2 Classifications

This refers to the categories that waste material is grouped into for identification and analysis e.g. paper, plastic, glass, metal etc. There is no 'right' or 'wrong' classification system and classifications should relate to the objectives of the study being conducted. There are however, a number of key considerations that need to be addressed before choosing your classification system and undertaking an analysis.

- **Which classifications?** Classifications are most commonly broken down by material type (e.g. paper plastic, metal, glass), but can also be categorised by function (e.g. junk mail, fast food containers), potential use or disposal route (e.g. recyclable, combustible) or origin (eg. garden waste, construction and demolition waste). The divisions must reflect the information sought – so think about why you are undertaking the analysis and what the data will be used for.
- **How many?** When gathering primary data, there is a temptation to use as many categories as possible, (in order to cover everything you might possibly want to get from the data), but this creates a number of problems. As a general rule - the more categories used, the slower the sorting process. Therefore either the number of samples must be compromised, or extra expense incurred. Furthermore, a greater number of categories inevitably means less material in each classification, which leads to a lower level of statistical precision for each classification. Therefore, think carefully about which categories you really need.
- **Practicality.** Classifications should be formulated so that it is easy for sorters to identify what material is (and is not) included, and so that each object is covered by a single unambiguous classification. Although more categories can mean that 'everything has a place' it can also create confusion and lead to errors and inconsistencies during the sorting process.
- **Compatibility.** Classifications should ideally enable the comparison of data, not only between waste streams within your locality, but also between localities. This is for the purpose of benchmarking and aggregation of data at regional and national levels. For example, if you want to compare amounts of cardboard, but the analyses have classified paper and cardboard together, this would not be possible.

  There is therefore a danger in using too few classifications. On the other hand use of a large number of differing classifications can make it complicated to compare data, and data then has to be consolidated or manipulated before it can be compared.
- **Reporting versus operational requirements.** Again you need to consider what the data is going to be used for. Consider how it may be possible to gather information in a way that suits practical operational considerations but allows the information to be consolidated into appropriate classifications for reporting purposes.

Box 11

Useful Tips

Which category does this bit of rubbish fit into?

A common difficulty is deciding how to classify certain items that contain more than one type of material – such as a multi-layer carton that contains paper, plastic coating and a foil liner. A good rule of thumb is to classify it according to the material that makes up the greatest weight. This will often be a subjective judgment but it is usually fairly obvious. In the case of the multi-material carton it would normally be classified as paper, as that makes up the greatest weight. The audit methodology should specify how these materials are classified.

A sensible and commonly applied solution to the above issues is to use different tiers of classifications – usually primary and secondary. So for example a primary classification of paper might be broken up into secondary classifications of News, Periodicals and Magazines, Office Paper, Cardboard, and Other Paper. This means that, as long as standard primary classifications are adopted, then data can at least be aggregated at the primary level, while allowing any number of secondary classifications to be used in order to tailor the analysis for the desired purpose. If you want to go even further, then tertiary classifications can be used, but remember this will slow down the sorting, and the reliability of the data in these tertiary classifications will be low. Figure 4.1 gives and example of how primary, secondary and tertiary classifications could be broken down for paper.

PRIMARY	SECONDARY	TERTIARY
Paper	Cardboard	Corrugated Card
		Paperboard
	Newspapers, Periodicals and Magazines	Newspapers
		Periodicals and Magazines
		Junk mail
	Office Paper	Office paper
		Envelopes
	Other Paper	Multimaterial
		Waxed & coated
		Soiled & contaminated
		All other paper

Figure 4.1 Example of classification tiers for paper

Industry Standards. No official set of standardised classifications currently exists in the UK or elsewhere in Europe, although these are under development. The Welsh Assembly has conducted the most comprehensive study undertaken (published in December 2003) since the Environment Agency (1997) and NHWAP (1994). The waste categories in this study were derived from accumulated knowledge and experience the field and may be used in a national survey. Appendix 2 contains some of the main classification systems currently used in the UK and elsewhere in Europe.

The different classification systems have been developed for a range of different objectives. For the purposes of this guidance, the existing classification systems have been reviewed and a suggested set of categories derived for use at a local level when monitoring household waste (Table 4.1).

Regardless of the number of sub-categories used at the secondary and tertiary levels, the primary level categories allow the materials to be aggregated to a common set of categories that enable comparisons with other local and national datasets. The suggested secondary classifications account for materials arising in recycling schemes that can help focus on areas for improvement - for example on how to improve capture rates when undertaking a compositional analysis as part of a wider research programme.

Table 4.1 Scheme Monitoring Classification List

Primary	Secondary
Paper	Newspapers
	Magazines
	Other Recyclable Paper
	Paper Packaging
	Non-recyclable Paper
Card	Liquid Cartons
	Board Packaging
	Card Packaging
	Other Card
Dense Plastic	Plastic Bottles
	Other Dense Plastic Packaging
	Other Dense Plastic
Plastic Film	Other Plastic Film
	Packaging Plastic Film
Textiles	Textiles
	Shoes
Glass	Glass Bottles
	Glass Jars
	Other Glass
Miscellaneous Combustibles	Treated Wood
	Untreated Wood
	Furniture
	Disposable Nappies
	Other Miscellaneous Combustibles
	Carpet and Underlay
Miscellaneous Non-combustibles	Construction and Demolition
	Other Miscellaneous Non-combustibles
Ferrous Metal	Ferrous Food
	Ferrous Beverage Cans
	Other Ferrous Metal
Non-ferrous Metal	Non-ferrous Food
	Non-ferrous Beverage Cans
	Other Non-Ferrous Metal
WEEE	White Goods
	Large Electronic Goods
	TV's and Monitors
	Other WEEE
Hazardous	Household Batteries
	Car Batteries
	Engine Oil
	Other Potentially Hazardous
	Identifiable Clinical Waste
Organic Non-catering	Garden Waste
	Soil
	Other Organic
Organic Catering	Home Compostable Kitchen Waste
	Non-home Compostable Kitchen Waste
Fines	Fines

Box 12

Useful Tips

In order to get a more accurate sample, it is better to sort more waste at a primary classification level and take a sub-sample at a secondary or tertiary level.

4.3 The Relevance of Waste Statistics and Obtaining a 'Good Sample'

As it is not practical to measure and classify every single item of waste that is generated, it is necessary to gather information about the waste stream by takings samples. There are an enormous range of things that will affect the types and amounts of waste that are generated in different places and at different times. As well as this, the approach used to gather information about waste can add biases and variation. How a sample is obtained therefore is very important. The application of statistics to waste information (although not an exact science) is a way of quantifying the levels of variation that are found and of aiding in the prediction of what can be expected - and so aiding in obtaining a 'good sample'.

The most important principles in determining whether the information you obtain is a good reflection of reality are fundamentally quite simple: The sample should reflect as closely as possible the characteristics that are found in the population that the sample is being taken from; ideally waste should be sampled as close as possible to the state in which it was when it was first disposed of; and it should be analysed in a manner that alters its properties as little as possible, whilst obtaining the desired information. These principles are expanded on further in the following sections.

4.4 Sampling Strategy

The sampling strategy is the process of going about obtaining a good sample. Having determined which waste stream(s) to target and the information you want to try and find out, the next step is to make sure you define the key variables that will influence your targeted waste stream(s).

Waste generation and composition can vary according to a range of factors, including, the type of collection system used, and the type of housing, land use, and socio-economic factors. Box 14 discusses some of the most common factors. Although which factors are most important in relation to waste arisings and composition is a complex issue, generally speaking the factors with the largest influence have been shown to be the type of collection systems operated by an authority and the season in which the measurement takes place. A sampling strategy should aim to account for as many of the most relevant variables as possible so that what you sample is representative of what you would find across the whole authority or area that you are concerned with for the study.

One way of minimising the risk of potential biases is to take a random sample. If you were sampling household collected waste streams for example, this would mean sampling waste or recycling from specific households pre-selected on a random basis from anywhere in your area. Or if you are sampling at a CA site or similar, this could mean randomly sampling vehicles as they entered the site. The problem with totally random sampling is that it is usually not practical in most circumstances. In the case of household collected wastes it would mean driving all over the area to collect the sample and this could clash with collection schedules and take too much time. Random sampling at CA sites is valid in principle, but again creates operational difficulties because vehicles do not necessarily enter the site at times that suits a pre-selected random sampling schedule.

There are a number of alternatives, but the best and most commonly used is what is known as a Stratified Random Sampling technique. This method involves dividing your sample population into different 'strata' that reflect the main variables you expect to encounter, for example: housing type; socio economic factors; the type of collection systems provided (if these are not the same for all households); or in the case of CA sites, types or sizes of vehicle. Samples are then taken from each of these strata in proportion to their size in the actual population (or if this is not done then results should be scaled up to reflect their proportions in the overall population). An example of a hypothetical Stratified Random Sampling schedule in provided in Appendix 3.

Key concept Box 13

The way that waste is sampled, collected and handled affects the characteristics of the constituent materials and therefore the accuracy of your results. For example if you compact materials or mix them together in a bulk sample, absorbent materials will tend to soak up moisture from other constituents in the waste, increasing their weight, and materials can get broken into smaller pieces and 'homogenised'. This means that no matter how much you might sample, the way that the sample is treated will still affect the results in the same way. The ideal in terms of analysing the waste is to sample it in the same condition that it is in when it is put in the bag. This means that methods that collect and handle the waste as close to this condition as possible will yield more accurate results.

Box 14

Factors Affecting Household Waste Composition

The following factors have been shown to influence household waste composition. This is not a comprehensive list and some of the factors are interrelated - such as housing type and socio-economic factors. This list is provided to illustrate the variety of influencing factors.

- **Time.** Waste can fluctuate significantly between days of the week, between weeks or months of the year and between years.
- **Seasonality, weather and climate.** Seasonality primarily affects growth rates of organic garden waste, but also consumption patterns – eg. Christmas, holidays, types of food eaten, activities undertaken. Weather has similar effects but creates fluctuations within the overall pattern of seasonality. Climate has a similar but larger baseline level effect within each geographic area.
- **Geography and land use.** The activities that occur within each area under consideration will have a clear effect on arisings composition – land use based activities such as rural, urban, agricultural, residential, commercial, industrial will all influence waste composition at a fundamental level.
- **Demographics.** The age, professional and education structure of the population, have been shown to be correlated with different levels of waste arisings, recycling scheme participation and residual composition.
- **Culture.** Culture can influence the types of activities undertaken, attitudes to waste, the type of education required to create recycling participation, and the types of food and goods purchased and hence disposed of.
- **Housing type** – This can have a large influence on waste arisings and composition because of the presence of gardens and numbers living in the household, and also because housing type is often closely related to socio economic and demographic factors
- **Socio-Economic factors.** The level of wealth influences consumption and disposal patterns at a fundamental level, but can also be correlated to other factors such as recycling rates.
- **Types of waste and recycling services provided.** This has been found to have one of biggest impacts on collected household residual composition of any of the factors. The types of collection containers, and materials recycled can lead to significantly different capture rates for different materials, as well as influencing the arisings of materials such as green waste and construction and demolition waste in the household waste stream.

In the UK a common approach is to sample from different streets according to their ACORN classification. This is not necessarily the most significant predictor of variability in the waste however. Studies have indicated that the largest variation in characteristics of waste collected form households related to seasonality, the type of waste services provided and the presence of gardens - not socio-economic factors. [3]

It is worth emphasising that it is critical that the sample provides as close a reflection as possible of the population you are concerned with. Whatever information you derive from your study will be based on what you have sampled. Therefore, if you want to be able to use the results in a valid manner to say something about the wider population it must reflect the key characteristics of that population.

4.5 Good Housekeeping

The best sampling strategy in the world can be negated if the resulting survey is poorly carried out. Factors such as the accuracy and calibration of the scales that are used (where a weight base survey is being carried out), the care with which materials are separated during sorting, the training of staff, or the method of recording data can all influence the accuracy of the data obtained. Appendix 7 contains a discussion of some of these factors.

Box 15

Useful Tips

There are two types of things that are essential for obtaining good reliable data:

1) Good technical sampling

2) Good general housekeeping

4.6 Statistical Reliability

Once it is clear how you should be targeting your sample so that it is as close a reflection of the population as possible, the next question is: how many samples need to be taken to be sure that your results are actually meaningful and can give you some degree of assurance about what is really happening? To address this question a short diversion into statistical calculations is necessary. Unless we know the statistical reliability of our results we won't know whether the results are indicating something that is real or whether they just reflect a random fluctuation.

This section aims to explain in simple terms the key concepts needed to specify and interpret a waste analysis.

Most surveys sample a number of households or bins or a certain tonnage of material and then report the average of the values that are found (eg 26% Paper & card, 7% plastic, 8% glass etc). But it is not enough just to know these average (also known as 'mean') values. We want to know how likely it is that these average values are close to their actual proportions in

[3]Parfitt et al 1997

the waste stream from which the samples have been taken. This is known as the 'precision' of the result (sometimes it is also called the 'margin of error').

4.7 Precision

The level of precision is described by what is known as the Confidence Interval (CI). This basically tells us the range within which we think our result might lie. If the range is very narrow, then the result is very precise, if it is wide then it is relatively imprecise.

In addition to the Confidence Interval there is a measure known as the Confidence Level (CL). It needs to be decided how confident you want to be about your result. This degree of 'confidence' is called the Confidence Level. There is effectively a trade off between the Confidence Level and the precision of the Confidence Interval. 90% or 95% Confidence Levels are commonly used in surveying as they provide a sensible balance between confidence and precision. For a given number of samples, if you require your results to be more confident, it means being less precise, and if it is acceptable to be less confident it is possible to be more precise. This is illustrated in Figure 4.2 below.

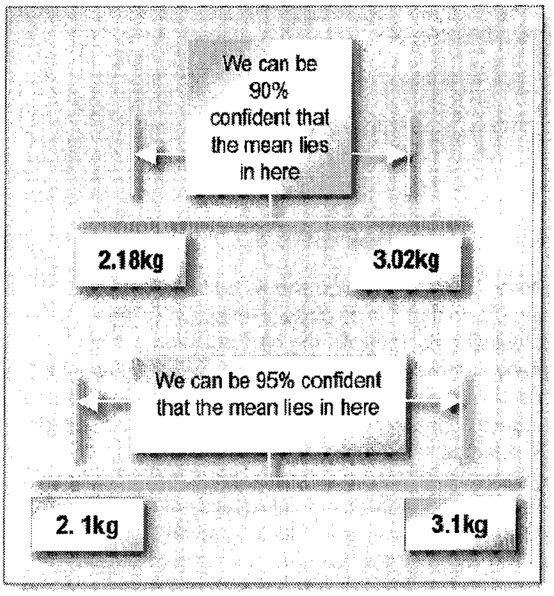


Figure 4.2 Example of 90% and 95% Confidence Intervals

Figure 4.2 above describes an example where the mean has been calculated to be 2.6kg and the CI +/- 0.5kg at a 95% confidence level and +/- 0.42kg at a 90% confidence level.

Whoever is conducting the survey and analysing the results should always calculate this information, and the survey design should allow this information to be reported. If this is not reported, then it should be recognised that you will not be able to determine the survey's statistical precision.

In order to calculate a CI, more than one sample is needed. Where material is analysed in a single 'bulk', sample it is not possible to provide a measure of precision as there is nothing to compare the 'bulk' sample to, and so no way of knowing what the level of variability of the components is.

It is critical at the outset that a decision is made on whether quantification on the statistical precision of the survey is required. All surveys methods have their strengths and weaknesses. However, it is important be aware of these potential limitations prior to commencing any study.

A reasonable level of statistical accuracy is a subjective judgement to a certain extent as it depends on what the information is going to be used for. However, for the purposes of waste analyses a result with a precision of +/-20% at a 95% confidence level could be considered appropriate (i.e. There is a 95% chance that the true (or population) mean is at worst 20% higher or 20% lower than the observed (or sample) mean. Another way to express it is to say if we sampled this population 100 times, then 95 times the value would lie in the given range).

Note: When specifying the precision level you want for a survey you must specify the elements of the waste stream that you want this level of precision for. The above level of precision is normally achievable for the major primary components of the waste stream (e.g. Paper, plastic and foodwaste in the case of household collected residual waste).

The results presented may look something like the following:

Paper	2.6kg/hh/wk	+/- 0.5kg	(95% CL)
		or	
Paper	26%	+/- 5%	(95% CL)
	Average amount found in sample	The true mean is probably within 0.5kg of the average. ie 2.1 - 3.1kg	There is a 95% chance that the true mean is within the range identified

Figure 4.3 How to interpret reported precision data

Note: when specifying a desired level of precision (eg x +/-20% at a 95%CI) the precision is expressed as a % of the mean. So if the mean is 2.6kg as in the above example, then 20% of that will be 0.52kg. It can be confusing however if the mean is expressed as a %. So, again as in the above example if the mean is 26% then 20% of that will be 5.2%.

Box 16

Calculations

'Confidence Interval'

Value of chosen CL under a t distribution

$$x \pm CL(StdDev/\sqrt{n})$$

Mean

Standard Deviation

Number of samples

Appendix 3 contains more detail about how to calculate the Confidence Interval.

Box 17

Useful Tips

Standard deviation: The standard deviation is a measure of how widely values are dispersed from the average value (mean). Microsoft Excel contains a formula called 'STDEV' which can be used to calculate the Standard Deviation.

4.8 Number of Samples

Once you have decided what level of precision you want to try and achieve, it is then possible to work out what size sample will be needed in order to achieve this. The required number of samples will depend on how much the materials you are sampling for vary in the waste stream. For example if every household threw out the exact same amount of all types of waste every week, then to find out what is in the waste, you would only have to look at the waste from one household. In reality however households throw out different amounts of a range of materials, and so it is necessary to look at a number of households to find the 'average' (mean) value.

Unfortunately, it is impossible to know for certain in advance of actually doing the survey what the required number of samples will be, as, until the survey has been conducted, there is no way of knowing what degree of variation will be found in the population. Practically speaking, the number of samples therefore can be determined based on experience – i.e. results that have been obtained from previous similar surveys. A note of caution needs to be sounded when using data from previous surveys as the level of variation found in the earlier surveys could be influenced by a range of factors such as sampling strategy, or demographic or seasonal factors. Where there is not historical data available that is considered adequate (i.e. the waste stream, sampling strategy, demographic or seasonal data etc is not comparable), then the best approach may be to simply undertake an initial random survey which is as large as is practicable. The data from this initial survey can then be used to determine more precisely the size of sample that will be required in subsequent surveys of the same population, and the sampling strategy can be progressively refined to more adequately account for variation that is found in the population.

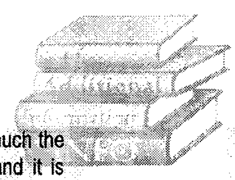
In statistical terms the number of samples can be determined through knowing either The Mean and Standard Deviation, or what is called the 'Coefficient of Variation' (CV) for whichever elements of the survey you wish to establish a certain level of precision. These methods of calculating sample size and their application are discussed further in Appendix 3.

The more that is sampled the greater the precision for each material. The key point is that it is important to know how much you can rely on the results achieved in your analysis. The higher the level of precision and the greater the degree of confidence then the greater the level of reliability you can attach to the findings of the survey. How precise your results are likely to be should therefore be taken into account when designing your analysis – and the final design should reflect the level of precision that will meet your requirements.

Appendix 3 contains further information about the statistical aspects of waste analysis including formulae which can be used calculate the required number of samples.

Box 18

Additional Information

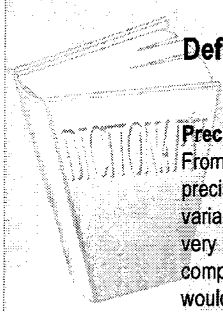


The coefficient of variation is a measure of how much the standard deviation varies relative to the mean and it is found by dividing the standard deviation by the mean.

Coefficient of Variation = Standard deviation / mean

or

$$CV = \mu / \sigma$$



Box 19

Definition

Precision & Accuracy
From a statistical perspective there is a distinction between precision and accuracy. 'Precision' is a measure of the variability of estimates of a measure. For instance, a very large sample could yield an estimated annual paper component of 26.2 ± 0.2% (95% confidence interval). This would be very precise. 'Accuracy' refers to how close the estimated value is to the true value; that is how much 'bias' there is in the reported result. The above example would not be accurate if for example seasonal factors had not been taken into account and the true value was 22.2%.

Box 20

Key concept

The size of the sample that you need does not depend on how big your city, town or district is, but on the level of variation that exists for the information you want to investigate. In other words the more consistently a material or object appears in your waste stream, the fewer samples you are likely to need to get a result that meets the required precision. For example plastic or paper are found in similar quantities in most household residual waste. On the other hand if you wanted to find out how many cans of hairspray get thrown out for example, you would probably need a massive sample, as there are only a relatively small number that get thrown out every day.

5.1 Introduction

The purpose of this section is not to explain how to physically undertake an audit, but to highlight some of the issues that may practically restrict the type of information you might be able to obtain. It is recommended that further information be sought if more detail is required – refer appendix 10 for a list of waste analysis references.

5.2 Health and Safety

Health and safety considerations mean there are limitations on what types of materials, objects and waste streams can practically be analysed. Some instances where issues may arise include:

- Heavy objects
- Sharp objects
- Hazardous waste
- Liquid or semi liquid wastes
- Clinical waste (unless stringent procedures are followed including the use of full PPE)
- Dusty waste
- Excessively odorous or gas producing waste
- Working in confined spaces or areas with minimal natural ventilation or light
- Working in areas where there are machinery and vehicles

[Note, the above list is not intended as a comprehensive hazard identification. Practitioners undertaking a waste audit are advised to obtain professional advice (e.g. HSE) to ensure that their procedures are compliant with legislative requirements and good practice]

5.3 Physical Amounts That Can be Sorted (Without Disruptions to Normal Working)

This is a common constraint on proposed methodologies. There is usually an optimal team size for different methods, and sample size is very often determined by how much a team can get through in a day. Increasing team size does not necessarily lead to higher productivity and can lead to health and safety issues if working in a confined space. Using two or more teams is an option but this will depend on available sorting space, and is less efficient unless both teams are fully occupied for the whole day.

5.4 Working Around Collections and Operations

When collecting samples directly from the kerbside, teams must work around the collection schedules of the regular refuse and recycling crews. Although it is possible that these collection schedules can be altered to accommodate the audit, this can lead to problems if it does not work perfectly, as samples can be interfered with or lost. There is also a need to collect the sample as quickly as possible to enable the sorting team to begin early and be able to sort the entire sample. The planned sampling schedule may have to be modified to accommodate these operational realities.

Similarly if an audit of a CA site (or similar) is being conducted the audit must enable the normal operations to continue with a minimum of disruption. This usually means a restricted space to conduct an analysis and a restriction on the size of the sorting team.

5.5 Sorting Space

An audit requires sheltered space of an appropriate size. The space also needs to be free of hazards, have good ventilation, be close to unloading and disposal points and not significantly interrupt normal operations. Space restrictions can in turn restrict the amount that can be sorted and or the types of materials that can be handled.

5.6 Set Out and Participation

If sampling household collected waste, obviously only those households that put their waste out can be included in the survey. This may lead to some ad-hoc variations in the sampling schedule if this factor is not allowed for in the survey design. A similar issue is identification of which waste or recycling comes from a single household. Some households pile up their waste along with their neighbours at a central point such as a telephone pole, end of a driveway etc. This waste should not be included as it is difficult to say how many households it comes from and its inclusion could distort the average household weights.

5.7 Privacy

Generally, any information that could identify an individual should not be recorded or reported. Readers are advised to seek professional advice on what data they can legally retain under the Data Protection Act.

5.8 Public relations

Ideally, you do not want to inform the public of an audit taking place, as this could alter their disposal behaviour. However, if some residents witness their rubbish being removed or sorted by unfamiliar non-council personnel they may become justifiably concerned. There are a number of procedures that can help mitigate this including the following:

- Collectors should be issued with a letter from the Council on headed paper explaining what is happening, and authorising the collection
- ID badges should be issued for all persons who may have direct contact with the general public
- The Council's call centre should be briefed to handle any calls from concerned residents
- Collectors should aim to collect the sample during a similar period, in similar uniform and in a similar vehicle to the normal collection crew
- Although important to sort the sample as near to the source as possible, unless absolutely necessary do not attempt to weigh and sort the sample beside the household.

Figure 5.1 Waste audit in progress

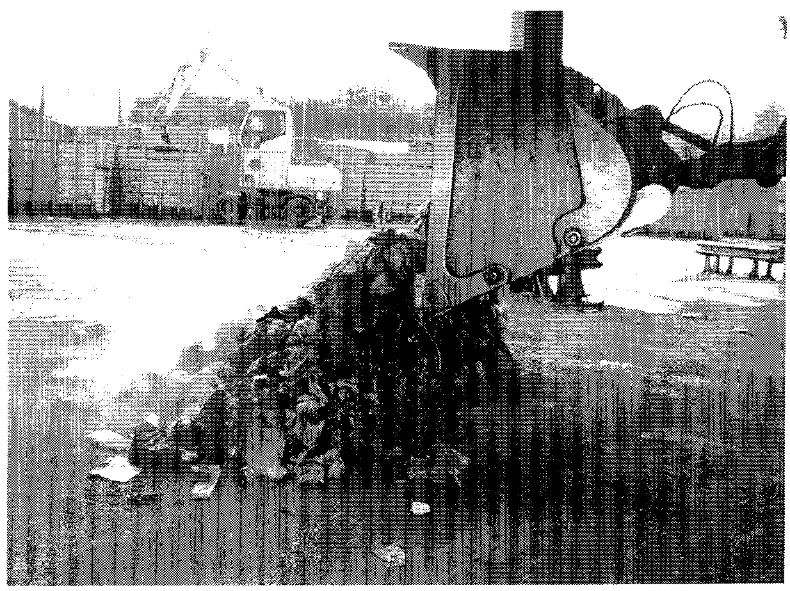


Figure 5.2 Bulk Samples

Box 21

Additional Information

Sorting Screens 50mm, 20mm, 10mm?

Sorting screens are used for a number of reasons. These include:

1. To reduce sorting time as part of a sub-sampling procedure
2. Prevent sorting of small particles that can otherwise be categorised as fines
3. Identify the size of different material to illustrate the potential material available for hand picking or mechanical sorting.

Although not a pre-requisite of a waste sorting exercise, many sorting and quantification methodologies use 'screens' to assist in the sorting of material. Anything that is smaller than the screen mesh size (typically 10 and 20mm holes in diameter) falls through, and is then categorised as 'fines'. This saves time in sorting insignificant and otherwise time consuming 'bits' in the waste, and provides a consistent definition of what is and is not 'fines'.

Assuming a 10mm screen is used, typically about-1% - 5% of material would classify as fines. Officially 50% of this material is estimated to be biodegradable (e.g. soil, food, paper) and counts towards BMW targets. The size of the screen that is used to sort material is the topic of some debate among waste analysis experts. Put simply, if for example you use a larger screen size, larger bits fall through. This not only means that more material ends up being classified as fines (and less ends up in other classifications), but that the composition of the fines material will be different. Therefore an analysis done with an identical methodology apart from screen size could yield slightly different results. Another factor is that if a larger screen size is used then this reduces the amount of time it takes to sort a load of material, and so more loads can be sorted in a given period of time, increasing the precision of the results.

Depending on the study's objectives and methodology, screens can be used as part of a sub-sampling exercise, or to assess the size of different material in the waste. For example, if a proposed MBT (Mechanical Biological Treatment) plant was to use screens to separate out material for recycling, then using similar screen sizes would enable you to determine the composition of the 'over-sieve' fraction – i.e. the material that you could expect the plant to separate out.

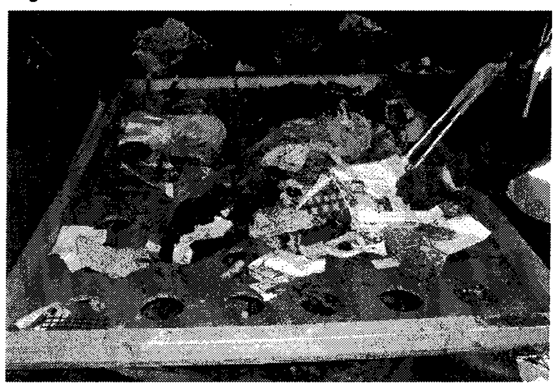
Although, the proportion of fines is mainly determined by the size of screen used, strong relationships have been identified between the waste sorting method and the amount of fines in a sample. If the waste is extensively mixed or handled, this can break down the waste into smaller fractions e.g. detaching soil from roots, glass containers being broken etc. This is likely to occur more frequently with bulk analysis methods that mix the waste (see figure 5.2) than those that sort the waste at a household level as it arises.

5.9 Additional Information

Depending on the purpose of the study, there may be a requirement to identify the moisture content and bulk density of the waste sample. The method to calculate these is relatively straightforward, (see annotated boxes) and although relative, will add expense and time to the study.

Waste composition data is often reported on a 'as received basis'. This is not the true weight of the material as it includes any moisture contained within the material itself. Different materials can hold different amounts of moisture. For example paper can hold a lot of moisture, unlike metal that can hold very little. Therefore, results could be misleading depending on what the data is to be used for. Typical material moisture content and bulk densities are shown in Appendix 7 and 8.

Figure 5.3 100mm screen in use



Box 22

Additional Information

'Moisture Content'

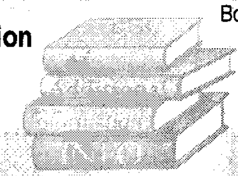
1. Weigh the sample to an accuracy of not less than 0.1kg. Record this weight as W1.
2. Spread the sample over a number of trays so that the height of the sample is not more than 250mm
3. Place in a fan assisted oven at 900 +/- 20c for 24 hours
4. Allow the sample to cool to room temperature and reweigh. Record this weight as W2.
5. The moisture content can be calculated as:

$$\%H_2O = \frac{(W1 - W2) \leftrightarrow 100}{W1}$$

Source ERRA 1993

Box 23

Additional Information



'Bulk Density'

1. Weigh a container of known volume, not less than 200 litres or more than 300 litres. Record this weight as W1.
2. Pour the sample into the container until it is overflowing.
3. Settle the contents of the container by dropping it three times form a height of 100mm.
4. Top up the container volume with remainder of the sample. If insufficient material is available, the unoccupied container volume (V2) should be measured.
5. Weigh the container and its contents. Record this weight as W2

For a filled container, the bulk density is calculated as:

$$Bulk\ Density = \frac{W2 - W1\ in\ kg\ /\ litre}{V1}$$

For a partially filled container, the bulk density is calculated as:

$$Bulk\ Density = \frac{W2 - W1\ in\ kg\ /\ litre}{V1 - V2}$$

Source ERRA 1993

Table 5.1 Common Sort and Weigh Techniques and Their Relative Merits

Method	Description	Advantages	Disadvantages
Bulk	Material from different samples eg different households or different vehicles is mixed together and sorted as one sample.	It is quicker to continuously sort a bulk sample and record data than to separate it into the smaller samples and sort and weigh them individually. This means more waste can be sorted thus improving the overall precision of the survey. This method is most appropriate where the concern is to obtain overall information for your area. The waste sample can be easily extracted, i.e. just take out of the back of the refuse collection vehicle.	Information is lost on bag weights, and the variation between the presence of different components in the bags. It is not possible to determine the variation that exists between households. It is difficult to explain differences between bulky samples i.e. getting under the surface. Comparison can only be made at a high level, i.e. area with a green waste collection, area without a green waste collection. Waste can be homogenised and moisture absorbed in the bulking process, reducing the accuracy of the data obtained. Because fewer (but larger) samples are taken this compromises the calculation of precision information.
Household Analysis	Each bag, bin or household lot is sorted as a separate sample.	Information is obtained on bag/bin and household weights, and on the variability of different materials between the samples. Because a large number of samples are obtained, the level of precision can be calculated to a high degree of confidence.	It is slower to sort by bag/bin or household, thereby meaning less waste overall can be sorted, and consequently compromising the overall precision of the survey.
Bulk Analysis Every *n*th household	Every 5th, 10th or nth household is collected and commingled to produce a bulk sample.	This allows you to have more control and know more precisely where your sample has come from according to e.g. socio-demographics, ACORN type, round information. It is a relatively quick method and a compromise between the bulk and bag analysis.	Same as bulk analysis. Can take additional time to set up. It is more difficult to collect the basic sample.
Sub sampling	Where there is a large amount of material, for example the contents of a Refuse Collection Vehicle – it may not be practical to sort the whole load. A statistically valid practice is therefore to take a 'sub-sample' of the waste (ie a portion of it), analyse it and extrapolate the results up to the full load.	Speeds up the sorting process, thereby meaning more samples can be taken and the overall precision of the survey improved.	Truly unbiased yet practical techniques are not often used.

Method	Description	Advantages	Disadvantages
Sub sampling (Cone and Quarter)	Material to be sorted is piled into a cone shape (usually with a digger or front end loader), and a cross section from top to bottom is (a quarter) taken for sorting and analysis. The process can be repeated until a sub sample of the desired size is obtained.	Material is mixed as it is piled up and the heavier elements tend to work to the bottom and the light ones to the top. This means that a reasonable representation of the material in the pile can be expected from the quarter. This is a subsampling method which enables less waste to be sorted from each sample and therefore more samples to be taken thereby increasing overall precision.	Material is frequently broken or split by the coning process making sorting harder and less accurate. This introduces further sampling errors i.e. how representative is the waste in the truck of the sample area/authority as well as now how representative is the sub-sample of the truck. A suitable digger or front end loader must be available when required. It is difficult to make the quartering process accurate and unbiased, especially as sub-sample selection can be influenced by the operators.
Use of screens	Screens are used to sort the waste on meaning that anything smaller than the screen size falls through and is classified as 'fines'. Refer Box 19 for more information.	Avoids having to sort through the time consuming small material in the waste stream.	Varying the screen size can affect the composition of the fines and of the other fractions of the waste. The composition of the fines is usually undetermined (However 50% is estimated to be organic material). Using larger screen sizes will result in less of the smaller materials (e.g. other paper, broken glass etc.) to appear in the sorted categories thus reducing the amount of material in these categories.
Conveyor	A conveyor line is used to sort material. Waste is fed into a hopper which is then moved along by the conveyor and items picked off similar to hand picking at a Materials Recovery Facility.	Theoretically increases the speed of sorting. Suited for bulk analysis.	Not easily compatible with use of screens. Must be transported to site and requires power source.
Moisture content analysis	Moisture is evaporated off waste at a constant rate and is weighed before and afterwards. The difference is the moisture content of the waste. Refer Box 22 for more detail.	Dry weight avoids variations that can occur through weather, liquids getting picked up by absorbent waste etc. Moisture content is useful information if the material is destined for some form of thermal treatment.	Reasonably time consuming and an additional expense to a normal audit. Not commonly undertaken for household waste and therefore dry weights are not as useful for comparison purposes.

Note: In practice each of these methods offers a trade off in terms of the detail and type of information that can be obtained and the size of sample and hence level of precision that the survey will produce.

Checklist of Points to Consider When Undertaking a Sort and Weigh Audit

Stage	Key Points to Consider	
Design Stage	Choice of waste composition collecting and sorting methodology clearly understood	☐
	Possible links to other research elements and the appropriate use of the methodology considered	☐
Choosing the sample	Sample areas clearly defined	☐
	Local circumstances taken into account	☐
	Liaise with other local authorities to assist the operation runs as smoothly as possible.	☐
	Special events e.g. Bank Holidays, Easter taken in consideration in the timing of the audit	☐
	The targeted sample meets the objects decided on	☐
	The choice of sample (dependent on the purpose of the study) reflects the balance of types of waste containment in the survey area, and data is recorded for reference during the analysis stage.	☐
Collecting the sample	The sample collection is consistent with normal collections, and is at the same time of the day as the normal collection if possible.	☐
	Residents not informed of survey to ensure behaviour is not altered.	☐
	Collection crews have local knowledge	☐
	Collection crews in regular contact with the project manger or a representative of the sorting team.	☐
	The normal refuse collection crew is fully aware of the sampling event.	☐
	Compaction of samples avoided if possible when not undertaking a bulk analysis.	☐
	Samples collected separately from other non-sample waste. Samples labelled if required	☐
Analysing the sample	All staff trained in sorting and H&S procedures	☐
	All required equipment obtained, calibrated and prepared for use.	☐
	Sorting procedures, logistics, and on site data management systems in place to ensure all samples can be sorted in time available and all information is securely recorded.	☐
	Samples able to be sorted as soon as possible after collection, to avoid possible decomposition, loss of samples etc.	☐
	Designated sorting area obtained that meets requirements	☐
	Sufficient experienced personnel are included on the audit team to ensure quality and consistency	☐

Possible actions that can be taken to address these points are listed in Appendix 7

6. Reporting

6.1 Reporting Standards

The final dimension that has to be considered when specifying a data analysis survey or programme is how the information is going to be reported. This is linked very closely with the first consideration, which is ensuring that the analysis has been correctly targeted and scoped. Clearly it is desirable that data be reported in a way that answers specific questions related to the reasons for undertaking the survey. In addition however, it may be that data to emerge from the study shows anomalies or different characteristics than expected, and therefore there needs to be flexibility to examine and explain these in the report.

As a minimum, the report should provide tables of raw or low-level data in the appendices that will enable issues to be examined if the data is put to further use after the report has been completed. It is essential that the report include details relevant to how the reported results were derived. Waste analyses can sometimes provide a lot of detailed data. It is important to recognise the level of detail required and request that the data be collected and presented accordingly.

Essential information provided in the report should include:

- The main research objectives
- Dates on which survey data was collected
- Location and description of the sample areas
- The precise waste streams sampled
- Description of the types of waste and recycling services provided by the Local Authority (particularly in the sample areas)
- Description of the proportion of properties serviced by the surveyed collection service, and other collections available
- Survey procedures, particularly in relation to the criteria used for deciding which items are included in the various classifications
- The presence of any potential biases in the results (e.g. seasonal factors, weather conditions, special local events).
- A careful description of what the results actually mean and how they should be interpreted
- Where appropriate, statistical confidence and standard errors should be reported
- The robustness of the data collected
- Appendices of raw or low level consolidated data so that the information can be interrogated and further analysed if needed.

Reports can be a time consuming exercise to prepare and therefore will add to the cost of an audit. When evaluating prices of tenders make sure you are clear what standard of report is being offered, as offering a lower level of reporting is frequently used as a way to reduce the price.

Box 24

Useful Tip

Optional Extras for reports:

- Information on calibration of weighting equipment
- Photos of material and sorting process
- Description of health and safety procedures
- Comparison with other data such as previous years data or national information

6.2 Data interpretation

Once the report has been completed and the data made available, it is important that you are able to understand and interpret the information obtained. A good report should make the meaning of the data clear. It should provide caveats on the use of the data and demonstrate some investigation or explanation of apparent anomalies. Nevertheless even well reported data needs to be handled correctly.

Things to think about when interpreting data:

- Exactly which waste streams is the information referring to? E.g. is it household collected (residual waste and recycling) or household residual?
- Is the data presented per household, per person or a total measure?
- Households do not always set out their refuse or recycling every week, so the waste analysed from a single household will not necessarily be equal to their weekly arisings (unless accommodation has been made for this and identified in the report).

- If any results appear slightly unusual, you should first check the secondary or tertiary breakdowns to see what materials have been included, and refer to the definitions of how items have been classified. (For example, were half-filled PET plastic bottles classified as PET plastic, 'other' plastic, food waste, 'other' organic, or were the contents separated out with the liquid going into organic and the bottle into plastic?) Ideally, this should have been made clear in the report methodology section.
- Pay attention to the statistical validity of the data. Most data will be valid at the overall level for the whole authority or area at a primary classification level. If data has be broken down into ACORN profiles datasets for example, or secondary classifications, this data will generally be indicative only - unless the original purpose of the study was to investigate composition at this level and the appropriate sample size sorted. Analysis at this level may be useful to explain characteristics of the overall data set. However, caution is advised in drawing specific conclusions, unless the data clearly has a high level of statistical precision.
- If data was obtained in one part of your locality, be careful not to assume that this same data applies to the whole area. Also, be aware that the composition of performance of one group only infers and does not predict the composition or performance of another. Therefore, the composition of one ACORN category B area may not be the same as another in a different part of the authority.
- Use of charts and tables. Pie charts are suitable where the data is showing proportions of materials in a waste stream, or proportions of material coming from different sources. Bar charts and line graphs are appropriate where comparison or time related data is being displayed. Axes and data points should be clearly labelled so it is clear what is being shown. 6.1 and Figure 6.2 illustrate a correct use of a pie chart and bar graph.

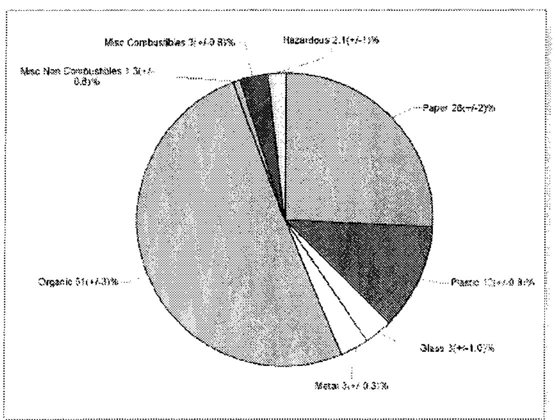


Figure 6.1 Hypothetical composition of residual waste.

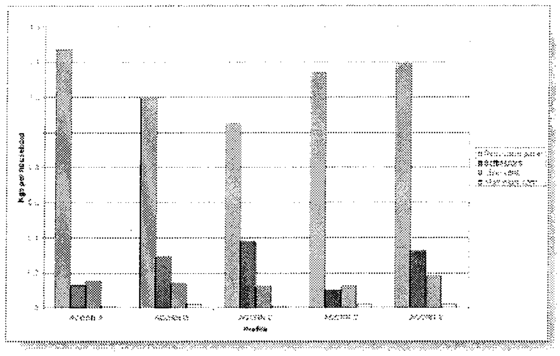


Figure 6.2 Comparison of weights of recyclable material between socio-economic profiles.

When examining trends over time or making comparisons it is advisable to use weight data rather than percentage data, as with percentage data everything must add up to 100% If one category (e.g. paper) goes up, all the others will go down distorting the true picture. In reality, the other categories may have also gone up, but not by the same levels as paper. Figure 6.3 and Figure 6.4 illustrate this.

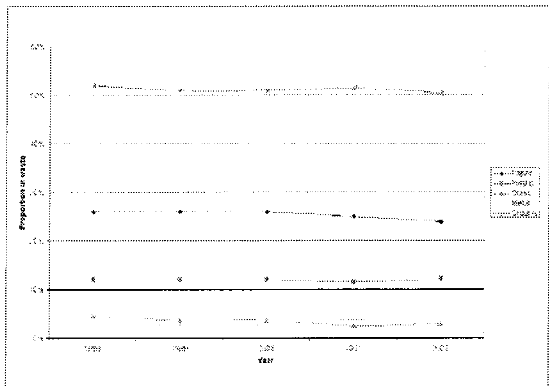


Figure 6.3 Change in composition weights 1998-2002 using percentage data

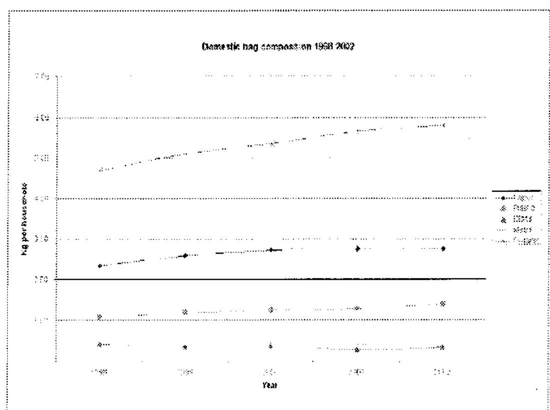


Figure 6.4 Changes in composition weights 1998-2002 using weight data

Other Waste Data initiatives:

Box 25

Welsh Protocol

AEA Technology supported by M.E.L. Research, Waste Research Ltd and WRc undertook a comprehensive national waste survey between November 2000 and October 2003. The Welsh Assembly government funded the study. This study:

1.Developed a protocol for analysis of each waste stream which is now being used in other studies

2.Provided further data on the composition of waste streams such as litter, bulky household waste and street sweepings

3.Provided initial data on the composition of commercial and industrial waste which is collected by local authorities

4.Developed household questionnaires from which individual households; characteristics could be compared with the composition of waste collected from individual households

5.Identified seasonal trends in the composition of the main waste streams comprising municipal waste

Analyses were conducted in 9 of the 22 local authorities. The research follows a pilot study in Wales in 2001-02 to develop a method for analysing the composition of the various wastes collected by local authorities. 2,788 household waste samples and 386 trade waste samples were analysed. In total 174 tonnes of waste were analysed. Sampling was done at 4 times in the year to assess seasonal variations.

More detailed information is available in the Executive Summary and Full report, available from Lisa Covington, Environmental Division, Welsh Assembly Government. Cathays Park, Cardiff, CF10 3NQ or www.wales.gov.uk

SWAT (Solid Waste Analysis Tool Project)

There are 14 European partners participating in SWAT. The project aims to implement a standardised methodology for solid waste analyses and improve the accuracy and comparability of municipal waste data across Europe. 5 demonstration cities (Newcastle upon Tyne, UK; Bilbao, Spain; Brescia, Italy; Brasov, Romania and Krakow, Poland) have undertaken a one year long waste analysis programme based on the methodology developed during the research phase of SWAT. The project consists of three phases,

Phase One – The Research Phase (2001-2002)

Phase Two – The Demonstration Phase (2002-2003)

Phase Three – The Dissemination Phase (2003-2004)

Further information can be obtained from http://www.swa-tool.net

Environment Agency (EA) Protocol

The Environment Agency is responsible for keeping the biodegradable waste content under review. As part of phase 3 of the Municipal Solid Waste (MSW) Analysis programme, the Agency is due to undertake a National household waste survey. The study will aim to determine the detailed composition of different sources of household waste in England and it is the intention to repeat this on an annual basis. The initial proposal to look at individual household waste has not yet been confirmed and the general approach has not been agreed between DEFRA and the Environmental Agency. At the time of writing the programme objectives have not been determined, the methodology has not been selected and there is no decision on whether the study will be undertaken internally or by an external contractor.

The programme intends to look at assessing individual household waste over a 52 week on week tracking study. Waste classifications will be material based (see appendix 2). There are no immediate intentions to develop a National Protocol, with operations expected to start in the late spring 2004 using the protocol used by the Welsh Assembly. Ultimately, a national protocol will however be developed.

The EA are currently in the process of evaluating the different approaches to monitoring local authority composition and their compliance under the LAT scheme. However, the EA have indicated that local authorities own BMW composition data will not be considered in any evaluation.

Information taken / adapted from www.wales.gov.uk, Warmer Bulletin, March 2004, personal communication with Terry Coleman (Environment Agency) January 2004.

National Assessment of Civic Amenity Sites

A report entitled National Assessment of Civic Amenity Sites (Chapter 2.3, pp 52-54) provides further information on CA site waste composition and assessment methods. The National Assessment of Civic Amenity Sites report can be downloaded from: www.networkrecycling.co.uk/casites

WRAP Compositional Study

WRAP are currently due to undertake a comprehensive waste composition exercise linked to their National home composting scheme. The objective is to undertake a compositional analysis of residual bin waste and Civic Amenity Site arisings in areas with high home composting uptake and control areas. The work will be used to assess the impact of home composting in relation to possible inclusion in the LATS scheme. Samples will be taken in June and September 2004 to capture differences in the peak seasons. Sampling will take pace at a household level integrating questionnaire survey data with compositional data.

7. Procurement

7.1 Specifying / Contracts

Having clearly established your data requirements and how this will be used, the next step is to procure the services to undertake a waste analysis. [NB if you undertaking the audit yourself, it is recommended you seek further advice beyond this guide before proceeding, especially regarding issues raised in section 5].

Virtually all waste audit service providers use their own proprietary methodologies, all of which will have pluses and minuses depending on the data required. It is therefore recommended that the precise methodology is not specified too closely, but that a reasonably detailed, output based, approach is used. There are four key elements which it is advised to include in the specification:

1. Scope and purpose of the audit. As emphasised in this document, this is the most important element as all the other elements of a waste analysis flow from this. Specify not only the information required, but also the purposes that you want if for, and how you may be planning to analyse and utilise the data in the future. This will assist bidders to design a methodology that will meet your requirements.

2. Classifications you wish to use for reporting and analysis purposes. Auditors may suggest classifications that they use for sorting purposes, and which may provide useful practical information – such as making distinctions between different materials. Be open to suggestions but ensure that the data can be easily consolidated into the classifications that you need for reporting and analysis purposes. The number and type of categories can be a selling point in waste composition studies. This can potentially be misleading as more waste categories and detail does not necessarily mean a better study.

3. The level of statistical reliability required. This is another key element of a survey. The various sampling and sorting methods proposed by different auditors will essentially involve trade-offs at various points, in terms of the detail, accuracy and statistical precision they deliver. As long as the methodology proposed can supply the information you have requested in the scope, the next consideration is that the data meets your required level of statistical reliability. One option is to request information from potential contractors on the level of statistical reliability that they expect their proposed survey design to achieve, including the level of precision that it should be able to deliver. There needs to be emphasis on the credibility of the sampling strategy in relation to the project objectives. You should be able to assess if a sensible sampling strategy is being proposed (e.g. area types, sample sizes, addressing seasonality, staff, training and quality procedures).

4. Reporting standards and information to be included. As discussed in the previous section you should be clear about the information you want and how it is to be presented. It is advisable to request to be provided with the raw data, or low level consolidated data, so that you can further interrogate it if needed.

If these four elements are fully covered, your specification should deliver the information you require. As it is now clear what you are asking, bidders will be able to structure and price their bids more accurately and therefore more competitively. However, it must be remembered that waste audits are very time dependent. The more detail you ask for, the longer it will take and hence more expensive it will be. Therefore, be realistic in matching your expectations with the available budget and time needed to organise and undertake a survey.

7.2 Evaluating Tenders

Aside from the usual considerations (track record, experience, Health and Safety, insurance etc), the tender evaluation will often come down to a trade off between methodology and price. Bids are often decided on price, because it can be difficult to sufficiently differentiate between the relative merits of different suggested methodologies. This can sometimes lead to an unsatisfactory methodology being used simply because it is the cheapest. Where there does appear to be a significant difference on price between bids, careful attention should be paid to ensure that the suggested methods are able to deliver comparable levels of quality.

Box 26

Useful Tip

Enquire about the personnel that will be used on the actual sorting. Who is actually sorting the waste? Have they been trained? Will they be adequately supervised? An experienced team will not only be quicker, but will be more accurate and consistent in identifying and classifying materials. The quality of the team can impact the results!

8. Reality Check

8.1 Is a Composition Study Required?

The final question to ask yourself before undertaking a waste composition analysis is essentially the same one that we started with - why do a waste composition analysis?

Having gone through the guide you should now have a better understanding of what a waste analysis is, and what it can provide. Revisiting this question will help firstly to make sure that a waste analysis will provide the information you need and, if so, it will help you to make sure you have got the correct focus and level of information required for the survey.

8.2 Checklist of Key Points:

Setting the Objectives

❑ A waste analysis can help:

- Evaluation of promotional work
- Monitor and improve existing waste management systems
- Develop and implement new systems
- Provide information for a waste strategy
- Benchmark performance
- Examine arisings data
- Provide research information
- Provide feedback to the public

❑ Is the planned study going to be compatible with:

- National data
- Neighboring authorities data
- Operational Data
- Other data held by the authority

❑ At what level is the analysis claiming to be representative e.g. WCA level, scheme areas?

❑ There is a range of methodologies, but the most commonly used are physical sorting and quantification methods. Is the method appropriate?

Practical Limitations

❑ What is possible is affected by:

- Budget
- Time
- Expectations

Meeting the Objectives

❑ The classifications used need to be:

- Able to gather the information you require
- Enough to capture the information needed, but not so many that they will create difficulties and confusion
- Practical
- Compatible with other data

❑ The areas sampled should be representative and should fit the needs of the survey e.g. the profile of the local authority, evaluation of a recycling scheme

❑ Make sure at the outset the spatial units i.e. WCA, scheme area.

❑ An appropriate sample size should be selected on the basis of the level of statistical precision required

Operational Realities

❑ An audit design will have to take account of:

- Health and Safety considerations
- Physical amounts that can be sorted in the time available
- The need to work around existing operations
- Sorting space
- Local considerations
- Privacy and public relations

Reporting

❑ Reports should contain:

- Dates on which survey data was collected
- Location and description of sample areas
- The precise waste streams sampled
- Weather prior to the sample period
- Description of the types of waste and recycling services provided
- Description of the proportion of properties serviced by the surveyed collection service,
- Survey procedures
- The presence of any potential biases in the results and how they should be interpreted
- The level of statistical precision achieved
- Appendices of raw or low level consolidated data

Procurement

❑ Include the following in your specification:

- Scope and purpose of the audit
- Classifications to be used
- The level of statistical accuracy required
- Reporting standards and information to be included.

9. Glossary of Terms

Accuracy – A statistical term meaning how close a value determined by a survey or similar is to the actual value in the population

ACORN - A Classification of Residential Neighbourhoods – refer appendix 5

Benchmark - measurement or comparison against a standard – usually best practice

BVPI – Best Value Performance Indicators – Local Government targets for recycling are set through the Best Value regime.

BMW - Biodegradable Municipal Waste

Bulk Density – the relationship between the weight of an object or material and the volume it occupies

CA (Civic Amenity) also known as Public Waste Disposal (PWD) Sites, and Household Waste Recycling Centres (HWRCs)

Capture Rate – The proportion of a available material that is collected by a recycling scheme

CIWM – Chartered Institution of Wastes Management

Classification (Waste) – the categories into which waste is divided for of analysis

Clinical Waste – Waste arising from medical related activity that may contain health related hazards

Cone and Quarter - a method for subsampling waste

Confidence Interval – a statistical term related to determining the precision of a result

CV – Coefficient of Variation. A statistical term, referring to a measure of the degree of variation relative to the mean

DOENI – Department of the Environment Northern Ireland

EA - Environment Agency

ERRA – European Recovery and Recycling Association

EPA – Environment Protection Act

Fines – small material (eg dust, small pieces of paper, food, etc) that is considered too time consuming to sort into other classifications

Hazardous Waste – Waste that has potentially acute human and environmental health effects. Refer to Annex III to Directive 91/689/EEC.

Household Waste – Waste that has originated from private households

LARAC – Local Authority Recycling Advisory Committee

LATS – Landfill Allowance Trading Scheme

LGA – Local Government Association

Margin of Error – a statistical term referring to the precision of a result

Mass Balance – a technique that measures the flow of materials through a system to try and account for the destination of all materials

Mean – a statistical term meaning the average

Municipal Solid Waste – All waste for which a local authority has responsibility

NAWDO – National Association of Waste Disposal Officers

OJEC - Official Journal of the European Commission

Participation – the proportion of all households that use a service. (usually defined as using a service at least once every 4 weeks)

PPE – Personal Protection Equipment

Precision level – a statistical term that describes the degree of confidence that can be attributed to the mean from a given sample

Recognition Rate - the proportion of available material that a household actually recycles

SEPA - Scottish Environmental Protection Agency

Standard Deviation – a statistical term describing variance from the mean

Statistical Validity – the degree in statistical terms to which a survey result is likely to be a true reflection of reality

Stratified sample – a method of dividing up a sample population to control for known variance within the population

Sub Sample – a smaller portion of a larger sample that is taken to reduce sorting time

WAG - Waste Action Groups

WRAP - Waste Resources And Action Programme

10. Index