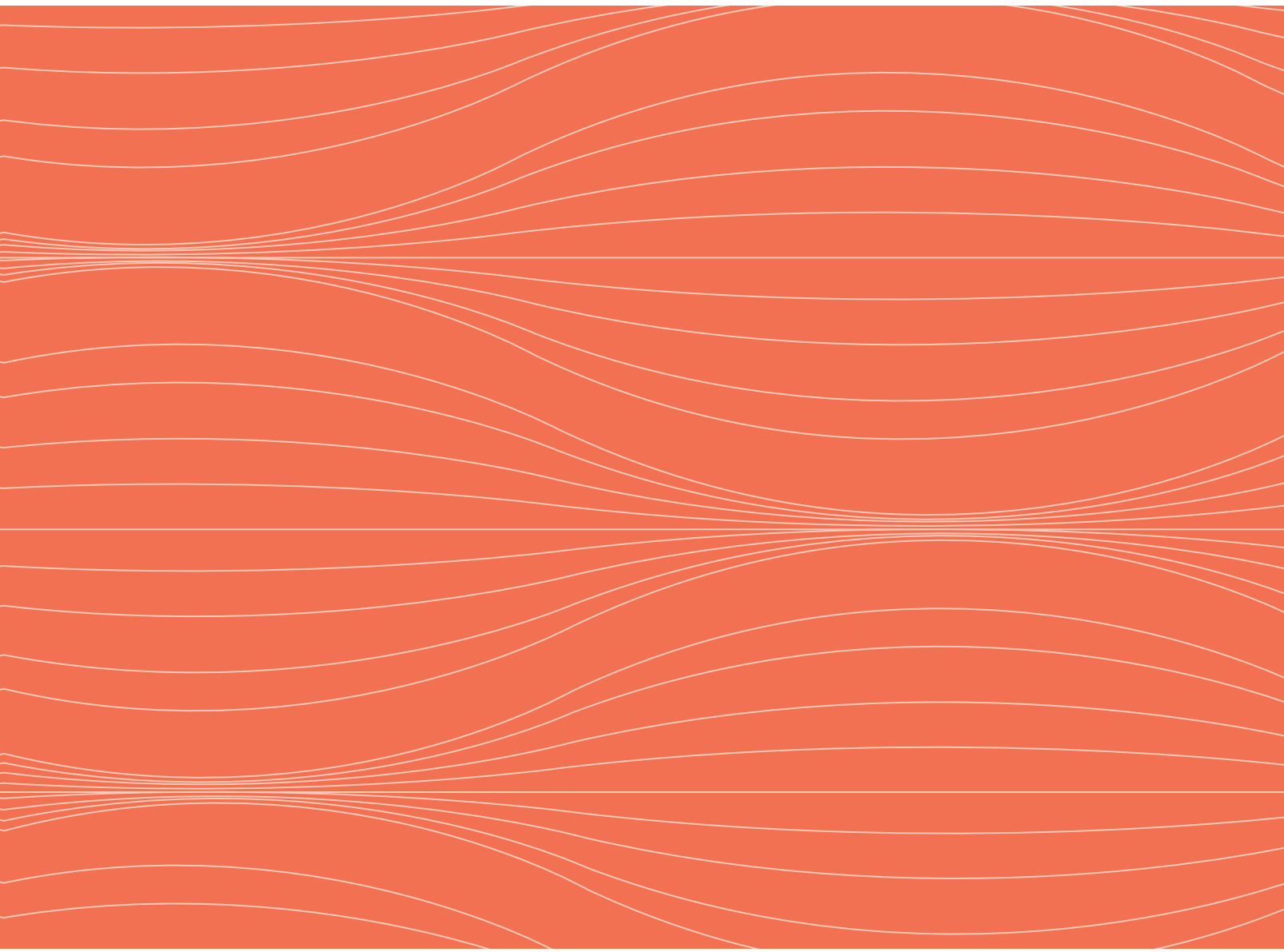
Guidelines for Conducting Household Kerbside Residual Waste, Recycling and Garden Organics Audits in NSW Local Government Areas

2008



Department of **Environment & Climate Change** NSW

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An important note about these Guidelines

The Guidelines for Conducting Household Kerbside Residual Waste, Recycling and Garden Organics Audits in NSW Local Government Areas 2007 have been developed to enable the collection of household data on waste and recycling quantities and characteristics within Local Government Areas in NSW. Following feedback on the Guidelines released in September 2007, minor adjustments have been made to clarify the intent of a number of details contained in the methodology.

These current Guidelines (May, 2008) replace the previous version. No substantive changes have been made to the technical aspects of the methodology.

The effectiveness of the Guidelines will be continuously monitored and revised where necessary over time. The DECC will notify key stakeholders if the Guidelines are further revised, however, DECC recommends that stakeholders regularly check the DECC website (www.environment.nsw.gov.au) to ensure that they are using the latest version.

These Guidelines outline key issues and methods for measuring household domestic residual, recycling and organic waste generation and the composition of the average household bin through audit processes.

Executive Summary

The *Guidelines for Conducting Household Kerbside Residual Waste, Recycling and Garden Organics Audits In NSW Local Government Areas 2007* have been developed to enable the collection of household data on waste and recycling quantities and characteristics within Local Government Areas (LGA) in NSW.

The Guidelines were developed as a result of two independent reviews of the *Domestic Waste Sub Stream Methodology* contained in the former Environment Protection Authority's (EPA) 1997 Draft Waste Stream Data Collection Methodologies. The reviews found a number of shortcomings with the previous methodology which could be improved. These Guidelines address the issues raised and have also benefited from feedback from DECC staff, Local Government waste managers and waste audit contractors.

Informed decision making needs to be founded on reliable intelligence. The minimum approach that will provide reliable information about the collection of household residual waste and resource recovery quantities and the composition of household bins within a LGA is a Single Snapshot Audit. This will provide a 'snap shot' of the status of household residual waste and resource recovery within the LGA at a single moment in time.

The recommended strategy for collecting household residual waste and/or resource recovery data involves the following:

- A minimum sample size of 260 households for audits of domestic residual waste and 350 households for both recycling and garden organics.
- The collection, bagging, sorting and analysis of the contents of individual bins on a household by household basis.
- Selection of households to be included in audits using Simple Random Sampling.
- Good practice, in terms of sustainable residual waste and resource recovery management, indicates that as a minimum to provide sound waste stream intelligence information, a single audit could be conducted on a yearly basis.

For councils wanting to undertake an audit of both domestic waste and recycling/garden organics at the same time, simple random sampling should be used to determine which households are to be included in an audit. Councils should randomly select the sample for recycling/garden organics, i.e. 350 households, and then randomly select 260 households from this sample to audit domestic waste. In this way domestic residual waste, recycling and garden organics can be collected, sorted and analysed at the same time.

Table 1 summarises four options for the recommended approach for audits of household kerbside domestic residual waste, recycling and garden organics.

Table 1 – Recommended options for household waste audits

Option	Stream	Timing	Method Of Collection	Sample Size (minimum number of households)
1	Domestic Residual waste (only)	Undertaken over 1-2 week period	Random selection of streets and households –bin by bin method.	260
2	Recycling (only)	Undertaken over 1-2 week period	Random selection of streets and households –bin by bin method.	350
3	Garden Organics (only)	Undertaken over 1-2 week period	Random selection of streets and households –bin by bin method.	350
4	Combined Domestic Residual Waste, Recycling and/or Garden Organics Audit	Undertaken over 1-2 week period	Random selection of streets and households –bin by bin method.	350 (recycling and/or garden organics) and 260 (domestic waste)

*For a combined audit the sample size should be 350 recycling, 350 garden organics and 260 residual waste . (See section 3.4).

The review also concluded that in many cases councils are seeking *more* specific data to help them better understand variations in household waste generation, resource recovery and bin composition due to seasonal factors. Three alternate approaches for the collection of more detailed household waste and resource recovery data enabling the measurement of this factor are also provided in the methodology in Part 5.

The three alternative approaches are:

- Optimal sampling (Quarterly surveys);
- Cyclic sampling; and
- Rotational 4 year sampling.

Specific information regarding audits for garden organic material is also discussed in Part 6 of the Guidelines.

Part 1. Background

1.1 Introduction

The Guidelines for Conducting Household Kerbside Waste, Recycling and Garden Organics Audits in NSW Local Government Areas 2007 (the Guidelines) have been developed to enable NSW Councils to collect data on household waste quantities and waste characteristics within their individual local government areas (LGA). The Guidelines will enable users to determine household residual waste and resource recovery quantities and the composition of the average household bin at the kerbside. The data collected can be used to provide policy makers in both state and local government with information for strategic decision making and to assist in developing programs to support the targets and outcomes set out in the *NSW Waste Avoidance and Resource Recovery Strategy 2007*.

STRUCTURE OF THE GUIDELINE

Councils and other organisations undertaking household kerbside waste, recycling or organic audits should read the entire guideline, including the Attachments which include important detail that is not provided in the body of these guidelines.

1.2 Waste audit methods review background

The collection and analysis of waste and recovery data is an important process that is used to guide waste reduction and resource recovery efforts in NSW. A consistent waste audit methodology and reporting framework for measuring the quantity and composition of average household residual waste and/or recycling and/or garden organics bins at the kerbside will provide councils with the basis for reporting and evaluating their own overall performance as well as programs, sector and waste stream performance.

A consistent waste analysis approach will also enable the evaluation of regional resource recovery potential, comparison between areas, the collation of NSW-wide waste generation and composition information and the development of performance criteria and progress reporting against the goals and targets in the *NSW Waste Avoidance and Resource Recovery Strategy* (see Attachment 10).

In 2007, the Department of Environment and Climate Change NSW (DECC) undertook a review of the *Domestic Waste Sub Stream Methodology* contained in the *1997 Waste Stream Data Collection Methodologies Report* [2].

The purpose of this review was:

- To critically evaluate the sampling regime and data collection process contained in the *Domestic Waste Sub Stream Methodology* to ascertain if it would produce reliable findings representative and characteristic of household waste generation, recovery and composition for a LGA.
- To identify any shortcomings and problems with the framework for sourcing household residual waste and resource recovery data and recommend options and solutions for resolving problem areas.
- To determine if the sampling regime described in the *Domestic Waste Sub Stream Methodology* could be adapted to meet the current needs and information requirements of the DECC and stakeholders.

The review of the methodology identified a number of key issues that needed to be addressed. These are summarised in Attachment 7. The statistical analysis and recommendations in the review report have been subjected to a further independent peer review.

[2] Environment Protection Authority NSW 1997. Waste Stream Data Collection Methodologies Final Draft, EPA, Sydney.

1.3 Household Kerbside Waste Audit Guidelines 2007

The Guidelines address the issues raised in the review. It is anticipated that the methods described in the Guidelines will be further refined as the characteristics of the domestic waste stream evolve over time and as waste stream data becomes more reliable.

1.4 Benefits of conducting audits

Regular audits of household waste and resource recovery collection systems can provide data related to domestic residual waste generation rates, resource recovery rates, composition and waste statistics.

Undertaking regular waste audits can:

- Provide data to inform waste policies and planning at local, regional, state and national levels;
- Assist in identifying waste generation trends at local, regional, state and national levels;
- Inform performance reviews of waste systems and contracts;
- Highlight any materials that require alternative education strategies and/or collection systems to improve recovery rates;
- Enable organisations to develop and assess education and marketing strategies;
- Allow councils to compare performance levels between areas of similar size, population, demographics etc.;
- Contribute to the development of new strategies to manage domestic residual waste; and
- Assist the planning and development of producer responsibility programs.

1.5 Working together to get good data

Having reliable and robust data as the basis for policy, infrastructure and programs depends on key players working together:

- DECC provides waste audit methodologies and guidance based on robust statistical analysis and in consultation with key users and stakeholders;
- Key players including councils and waste consultants conduct waste stream kerbside audit data collections;
- Raw data is provided to DECC;
- DECC analyses the information provided from the audits, in collaboration with the relevant stakeholders, and reports:
  - Regional and state-wide data on minor components of domestic residual waste, recycling and garden organics streams
  - Regional and state-wide data on all major components of the domestic residual waste, recycling and garden organics streams
  - Performance against NSW Waste Strategy targets and outcome areas every 2 years
- DECC, councils and other organisations use the data to inform policy and program decisions.

All audit data supplied to the DECC will remain private and confidential. Only aggregated data which meets the requisite privacy provisions will be released.

1.6 Key considerations and issues in conducting kerbside audits

The following issues are important to consider before commencing an audit to measure domestic residual waste and/or resource recovery quantities and the composition of household bins.

(i) The timing and frequency of data collection depends largely on financial and resource availability and the intended use of the audit data once it is collected. The Guideline provides a recommended approach to undertake household audits. It also outlines alternative approaches which can be used to gather enhanced audit data as well as describing limitations with the use of certain methods.

(ii) The specific aim and purpose of the audit will determine the methods used to collect data. These set the parameters and boundaries of an audit process and assist in defining the level of information that will need to be obtained from an audit. Further information related to key planning considerations is provided in Attachment 1. Details about the potential impacts of the timing and frequency of audits is provided in Part 5 of the Guidelines.

1.7 Read the Attachments

The body of these Guidelines outline the key issues and approaches for measuring the quantities and waste characteristics of domestic residual waste and resource recovery at a local level. However, important detail and other key issues, including guidelines on Occupational Health and Safety and suggested audit reporting procedures, are provided in Attachments 1-9. Please ensure that you read these too.

Attachment 1: Planning Checklist

Attachment 2: Occupational Health and Safety

Attachment 3: Reporting Audit Data and Preparing a Domestic Kerbside Waste Audit Report

Attachment 4: Report Template

Attachment 5: Raw Data Sheet – Individual Bin

Attachment 6: Material Type and Material Items

Attachment 7: Key Issues with 1997 EPA Methodology

Attachment 8: Sample size calculation

Attachment 9: Glossary of Statistical Terms

Attachment 10: NSW Waste Avoidance and Resource Recovery Strategy 2007 – Key Elements

Attachment 11: Simple Random Sampling Estimation

Attachment 12: Estimation for Stratified Sampling

Part 2. General Structure and Framework for Auditing

2.1 Timing and frequency of audits

The number of audits undertaken in any given study area is determined largely by financial and resource considerations as well as the purpose and rationale for collecting data.

During the audit planning phase, consideration should be given to the potential impacts of seasonal effects and changes in weather[3] on the variability of domestic residual waste, recycling and/or garden organics data. Such factors will have some bearing upon levels of domestic residual waste, recyclables and garden organics generated and the composition of household bins. Timing is therefore an important consideration during any audit planning stage.

Overseas studies have highlighted the fact that waste data can be highly variable across different time scales including:

- Daily (e.g. according to patterns of waste collection, business hours and social activities, weather);
- Weekly (particularly weekday/weekend and patterns of business activity through the working week);
- Monthly (e.g. according to changes in the activities of waste generators such as building demolition);
- Seasonal (e.g. more garden organics in spring/summer); and
- Yearly or longer (e.g. changes in the waste stream catchment size or characteristics, economic activity, changes in the waste management systems)[4].

2.2 Basic audit approach (single snap shot audit)

Good practice, in terms of sustainable residual waste and resource recovery management, would indicate that as a minimum to provide sound waste stream intelligence information, a single audit could be conducted on a yearly basis. A single audit within an LGA will provide a 'snap shot' of domestic residual waste and resource recovery quantities and the composition of household bins at a single moment in time. A single audit should be undertaken over a 1-2 week period.

The information gained from a single snapshot audit will be useful for councils to assist them to understand the amounts and compositions of the residual waste and/or recycling and/or garden organics streams at a particular time across the LGA as a whole. Data reported to the DECC will also enable comparisons to be made between the composition and quantities of individual household bins in LGA's where audits are undertaken at a similar time of the year.

It should be recognised, however, that a single snap shot method does have many limitations and will not be sufficient to enable councils to measure other factors which influence household waste generation and resource recovery rates such as:

- Seasonal variations (e.g. the impact of seasonal variation on household waste generation);
- Changes in population and demographics;
- Changes in weather/climate conditions; and
- Changes in the behaviour of individuals.

Options for undertaking a more thorough and comprehensive study which considers items such as these will require an alternate audit approach (see Part 5 of the Guidelines).

[3] E Klee, A.J. 1993. 'New approaches to estimation of solid waste quantity and composition' in Journal of Environmental Engineering, 119, pg. 248-261.
[4] New Zealand Ministry for the Environment (2002) Solid Waste Analysis Protocol, Ministry for the Environment, New Zealand.

Part 3. Sampling

Table 2: Summary of Sample Sizes

Stream Being Audited	Sample Size (households)
Domestic Residual Waste (only)	260
Recycling (only)	350
Garden Organics (only)	350
Combined Domestic Residual Waste, Recycling and Garden Organics Audit	350 households (recycling and organics) and 260 households (domestic waste)

*For a combined audit the sample size should be 350 recycling, 350 garden organics and 260 residual waste . (See section 3.4).

3.1 Sampling regime

To ensure that results are as reliable as possible, it is necessary to devise a sampling regime which is representative of the whole LGA. Representative data with defined uncertainty and confidence intervals can only be obtained if the sample size is determined using prior statistics (mean, coefficient of variation (cv), confidence interval), derived from trials or previous full audits of the study area.

Using pre-existing data to estimate means and the coefficient of variation will enable calculation of the sample size needed to achieve a required confidence interval. This procedure will yield reliable estimates which, within constraints, may be used to predict longer term household waste generation rates. Note that the coefficient of variation (standard deviation divided by the mean) describes the relative dispersion or spread around the mean, while the confidence interval yields information about the reliability of the mean. For further information about these concepts see Attachment 8. Coefficients of variation are extremely useful for comparing variability between surveys and also comparing similar surveys conducted in other study areas.

3.2 Domestic residual waste sample sizes

The sample sizes outlined in this section were calculated using previous NSW local government audit data prepared as part of the review of the 1997 audit methodology.

The sample size was calculated based on 90% confidence with ±10% uncertainty using previous audit data. Using this approach, it has been determined that bins from 260 households will need to be audited to obtain data which is both meaningful and representative of any given LGA.

A sample size of 260 households (refer Table 2) will provide sufficiently reliable estimates of the major components of the household residual waste bin, including:

- Food organics
- Paper
- Plastics
- Metals
- Textiles
- Glass

Over time, as more data is collected within any given study area, there will be an opportunity to refine the minimum 260 sample size that the methodology recommends. The formula for calculating sample sizes using data collected through audit processes over a period of time is provided in Attachment 8.

For minor components of the waste stream, which may include items such as batteries or bottle tops, the minimum sample size required to achieve 90% confidence at ±10% uncertainty is 6850 households. This sample size is impractical for any single LGA. However, combined data from study areas across NSW can be used to derive reliable data on minor components, which will then be representative of the entire state. The DECC will consolidate the audit data to produce regional and state-wide profiles on minor components of the waste stream. It is therefore important that each audit also measures minor components of the waste stream where possible. DECC will also consolidate data on major components from studies to produce state and regional household profiles.

3.3 Dry recycling sample sizes

Based on available data from previous NSW local government audits of 8 Council areas it was calculated that recycling from 561 households per LGA would need to be audited to achieve 90% confidence with ±10% uncertainty. However because of the small number of councils used for this calculation it was recognised that this sample size may be higher than necessary to achieve the specified accuracy, particularly where previous audit data is available which is both reliable and robust.

In recognition of this, a smaller sample size of 350 households (refer Table 2) at ±50% uncertainty can be used for the collection of data for major components in the recycling stream.

Alternatively, if information is available on standard deviations for all components in the recycling stream from previous kerbside audits, then this information may be used to calculate the optimal sample size for the next audit to achieve the 90% confidence level with ±10% uncertainty. The DECC recommends that those councils with previous household recycling audit data recalculate the sample size specified in this methodology. For those councils unable to recalculate the sample size, 350 households will provide a good starting point for audits of household recycling. The formula used to calculate sample size is outlined in Attachment 8.

3.4 Combined stream based audits

For councils wanting to undertake a combined stream based audit of domestic residual waste and dry recycling and/or garden organics, councils may use a sample of 350 households to audit recycling and/or garden organics and randomly select from these a subset of 260 households to audit residual waste (refer Table 2). Simple random sampling should be used to determine which households are to be included in the residual waste component of the overall audit.

3.5 Sampling strategy

Two sampling methods are currently used in NSW to source data on household waste quantities and characteristics. These are:

(i) Per household method: which requires the collection and analysis of the contents of bagged residual waste / recycling / garden organics from individual households ('bin-by-bin').

(ii) Aggregation method: which allows for the contents of household bins to be combined and the analysis of the contents of aggregated waste.

Both methods will yield valid estimates of the means of each waste component per household. However, there are two important differences between the methods:

(i) The aggregation method cannot produce unbiased estimates of ratios or fractions of waste components per household, therefore estimates will be biased towards households producing more residual waste, recycling or garden organic material.

(ii) The aggregation method does not allow the determination of standard deviations of component waste or the total waste directly.

The same considerations set out in (ii) above also apply to the aggregation of waste from multi-unit dwellings. The aggregation method will not deliver an accurate calculation of waste ratios per household, and will artificially reduce standard deviations.

Based on an analysis of each of the sampling methods described above, it has been determined that data should be collected on a household by household basis ('bin-by-bin'). This provides a more representative and robust method to gather data on household residual waste and resource recovery quantities and characteristics.

The collection of data on a 'bin-by-bin' basis will enable profiling of each LGA and generate statistics related to household waste generation and bin composition as a reasonable basis for decision making. The DECC will also be able to use data provided across NSW to validate state-wide generation rates and determine household bin composition profiles.

3.6 Data collection and reporting

Individual household data obtained through audits of domestic residual waste, recycling and/or garden organics should be recorded using the templates provided. Attachment 6 lists the material categories that must be used and the minimum data to be reported.

Part 4. Conducting the Audit

4.1 Key considerations in selecting the timing and frequency of audits

The following should be taken into account when selecting the timing and frequency of data collection:

- Auditing should be avoided during an atypical week such as a carnival, major religious festivity or any other major local one off social or cultural event. It is critical to have a sound understanding and awareness of the LGA and significant events which may impact upon household waste generation, bin composition and audit processes. During planning stages, consideration should be given to the timing of audits to avoid auditing during significant events which may occur. The DECC does not consider events such as school holidays as constituting an atypical week as these are systematic, ongoing and occur at similar times on a year to year basis.
- Repetition of surveys will allow for the development of time series data.
- Greater frequency in the number of audits conducted will enable measurement of associated impacts upon generation and composition including seasonal variation, socio-economic differences and changes in weather patterns etc[5].
- For more reliable monitoring, the ongoing repetition of audits is recommended.
- Areas with large seasonal fluctuations in population may need to be audited during peak and off peak seasons to account for population changes.

4.2 Confidentiality and privacy

Government agencies, councils and other organisations who use these guidelines for the collection of household waste characteristics within a given LGA, should ensure appropriate procedures are put in place to maintain the privacy of personal household information collected through audit processes. Strict protocols about privacy and confidentiality should ensure that the privacy of individual household information is safeguarded and upheld during the collection, sorting, disposal and data analysis stages of any audit. This includes ensuring that data collectors are made aware of processes which should be followed for the collection of information and that appropriate mechanisms are in place for the storage of data. In this context, the content of a particular household bin should be considered to be confidential information.

NSW government agencies are bound by the *Privacy and Personal Information Protection Act 1998* which outlines strict provisions for the collection, storage, access, use and disclosure of personal information by Government agencies.

Internal policies within an organisation related to confidentiality can also serve to guide the handling, storage and disclosure of information of a personal nature. Government agencies, councils and other stakeholders who use this document should ensure that the collection and storage of data is carried out in a lawful manner with consideration given to maintaining the confidentiality of information obtained through audit processes.

4.3 Selection of streets and locations

Samples should be collected over a 1-2 week period (depending on collection cycles) covering the whole LGA. To achieve this, the base population should be divided into sub-groups on the basis of a stratifying characteristic, such as daily collection zone boundaries.

[5] Note: To account for impacts other than seasonal variation (e.g. differences in waste quantities and bin composition based on varying social and economic characteristics in the population), councils and stakeholders will need to review the sampling methodology, introducing an additional layer of sampling, for example stratified sampling, to account for such variables in audits. See Attachment 12 for more detail on stratified sampling.

At the street level within each collection zone, the recommended number of households should be selected randomly. Any appropriate random sampling regime will be acceptable for this purpose. For example, random sample selection can be made using the random number generation function (RAND) within Microsoft Excel, to select a start street address from the rates database of a particular LGA.

Bins from these households should then be selected, so that every *nth* bin is selected from the start address. The total number of streets required to make up the total sample size will depend on how many households are available in the selected streets to be sampled.

Alternatively, a fixed and pre-determined number of streets can be randomly selected as above and the number of households to be sampled in each street can be calculated so that there is an even spread over the total number of streets selected.

4.4 Non presentation of selected bins

In the event a household has been randomly selected and their bin is not presented at the kerbside, data collectors should record a 'zero' (0) on the data sheet relating to this particular household. It is acknowledged that a large number of recorded zeros may result in the underestimation of waste data, however recording results from 'substitute' or 'replacement' households will potentially lead to overestimates. To address this potential issue, the following procedure should also be followed:

(i) Record households who do not present a bin as 'non presenters' on the recording sheets.

(ii) Where a bin is not presented by a household which has been included in the sample, data collectors should move to the neighbouring household, bagging and analysing the contents of bins as per these Guidelines.

(iii) Record bin data from replacement or substitute households on a separate sheet, with a note clearly identifying the household as a 'replacement' or 'substitute' household for the non presenter. While this action will introduce an element of bias into the study, the DECC acknowledges that additional sampling may be quite costly and not time efficient and therefore has suggested the collection of audit data from neighbouring households (i.e. replacement or substitutes) where non presenters are encountered.

Alternatively, councils may want to select the required number of additional households to account for non presenters through a random selection process. For example, if an audit of domestic residual waste from 260 households produces 60 non presenters, auditors could look at randomly selecting and auditing a further 60 households till they reach the nominated figure of 260.

For details relating to how individual household data should be handled and analysed in light of non presenters and replacement or substitute households, see Attachment 4.

4.5 Bin damage and effect on data capture

During audit processes, data collectors may come across households presenting bins which are damaged in one form or another, for example, a broken lid. It is possible that damaged bins may have an impact upon the contents of bins, particularly in the event of rain which may result in added moisture which would otherwise not be there, hence affecting the contents of a household bin. Unfortunately it is not possible to account for every possible variable which may impact upon the status of the bin (or its contents) located at the kerbside, therefore it is recommended that all households and their bins identified as part of the sample should be included regardless of the state of the household bin. Where obvious bin damage is apparent, this should be noted. For details related to the handling and analysis of data collected from bins subject to damage, see Attachment 4.

4.6 Auditing Multi Unit Dwellings (MUDs)

Where the random selection of households for inclusion in a study results in the selection of Multi Unit Dwellings (MUD), as opposed to Single Unit Dwellings (SUD), an additional layer of random sampling may be required to accommodate their inclusion. The reason for this is because MUDs often have different waste management systems (e.g. individual household bins or communal bins as well as other larger capacity bin configurations).

Where each household in the MUD has its own individual bin, they can be selected randomly. The number of households in the MUDs selected will then contribute to the total number of households required for a LGA.

Where communal bins exist in the selected MUDs then the whole contents of all of the bins should be collected and treated as coming from *(n)* number of households. All of these households can be counted towards the total number of households required for a study.

It is strongly recommended for those areas where a high proportion of MUDs exist, that stratified sampling[6] is used as opposed to simple random sampling alone. This will involve identifying the ratio of SUDs to MUDs and altering sample sizes accordingly to accommodate these proportions. See Attachment 12 for details.

4.7 Undertaking specific audits to understand MUD waste and recovery analysis and characteristics

Ideally, the appropriate sample size per LGA and for all MUDs should be calculated based on statistics (means and standard deviations and hence co-efficient of variations of total weights and individual components) available from previous audit data specifically from MUDs. This can be done by using the formula for calculating sample sizes provided in Attachment 8, for a defined accuracy (fixed uncertainty and confidence interval).

If previous MUD audit data is not available to enable calculation of appropriate sample sizes, the DECC can provide assistance to identify the best starting point for the collection of audit data. The DECC will review these Guidelines in the future to improve approaches for auditing MUD households.

[6] For definition of Stratified Sampling see Attachment 12

Part 5. Alternative Audit Approaches

As outlined in Part 1, the most basic approach to auditing is to conduct a single audit per annum however it should be recognised that this will only provide a snapshot at a given point in time. On its own such an audit will not provide a measurable and comprehensive picture on household generation, composition and waste and recovery characteristics, nor will it measure other impacts such as seasonal variation. Ideally the number of kerbside audits undertaken on an annual basis in any given study area should be sufficient to:

- Measure seasonal variation in household waste generation, resource recovery and bin composition;
- Develop and contribute to time series data;
- Monitor longer term variations in household waste characteristics.

Seasonal impacts on domestic waste and recovery rates can occur because of changes in population, for example in resort and holiday communities, or variations in leisure practices.

A series of alternate sampling methods are described below which can provide substantial additional information for use by councils.

5.1 Optimal sampling: quarterly surveys

To measure and account for seasonal variation in generation rates and composition, audits should be conducted on a quarterly basis, season to season, over a 12 month time frame. This is shown in Table 3 below.

Table 3: Optimal method accounting for seasonal variation

Audit Number	Season	Timing	Suggested Audit Duration
1	Summer	December	Mid January (1-2 week period)
		January	
		February	
2	Autumn	March	Mid April (1-2 week period)
		April	
		May	
3	Winter	June	Mid July (1-2 week period)
		July	
		August	
4	Spring	September	Mid October (1-2 week period)
		October	
		November	

Using this alternative for the first time would require the auditing of bins from 260 households per audit (i.e. 4 times per year per study area). For those wanting to also audit household recycling and/or garden organics, the initial sample size required would be 350 households, per audit and study area[7] . Over time, however, as more data is collected through kerbside audits within any given LGA, there will be an opportunity to reduce sample sizes.

To maintain a consistent and structured approach for the collection of data, audits should be undertaken midway through each season, over a 1-2 week period, depending on collection cycles. This will account for daily and weekly patterns of domestic residual waste, recycling and/or garden organics generation. While this is the optimal approach, it is recognised that some flexibility in the timing of audits may be required.

[7] Note: Those wanting to do combined audits of waste and dry recyclables, select 350 households with subset of 260 households for waste.

Audits conducted using this approach will enable councils to measure seasonal variation in generation rates and composition within a given LGA. Audits undertaken within the same timeframe and duration on a year to year basis will also enable the development of time series data and the monitoring of longer term variations, such as the impact of changing weather patterns and changes to the waste management systems within the LGA.

5.2 Cyclic sampling

Another option which can be used for collecting household domestic residual waste, recycling and/or garden organics data is cyclic sampling. Two cyclic sampling methods are described below. Both are similar in practice however they vary in the frequency of data collection.

The first cyclic method described involves auditing the content of household bins twice a year, alternating through seasons. Cycling through the seasons over a 2 year period can be considered as an alternative to quarterly sampling over a single 12 month period. Table 4 highlights the cyclic approach for the collection of data using similar timing and durational methods as outlined previously.

Biannual audits using the cyclic method will account for longer term variations in household residual waste, recycling and/or garden organics generation patterns and enable the measurement of changes in the amounts generated and compositional change over time.

Table 4: Cyclic method accounting for seasonal variation

Year	Audit Number	Season	Timing	Suggested Audit Duration
1	1	Summer	December	Mid January (1-2 week period)
			January	
			February	
1	2	Winter	June	Mid July (1-2 week period)
			July	
			August	
2	3	Autumn	March	Mid April (1-2 week period)
			April	
			May	
2	4	Spring	September	Mid October (1-2 week period)
			October	
			November	

As a second option, the cyclic method can be applied over a 2 yearly cycle (i.e. 2x audits every 2nd year) however 2 audits per annum would provide more robust data.

5.3 Rotational 4 year sampling

A further alternative to both the quarterly and cyclic methods is to conduct audits on a rotating basis over a 4 yearly cycle, (e.g. Audit 1– Year 1 – Summer; Audit 2 – Year 2 – Autumn etc.) This method will provide a snap shot of quantities and composition at a particular time and will show some seasonal variation but it will not account for other factors that may impact upon the amounts of residual waste, recyclable and garden organic material generated and on bin composition e.g. changes in population and demographics, changes in weather/climate conditions and changes in the behaviour of individuals, etc. Sample sizes to be used for this method are the same as those described previously.

Part 6. Garden Organics

There are a number of approaches that can be used to determine overall generation and composition of garden organics. This will depend on the information that council is seeking from the audit.

Kerbside audits are not always the most efficient or cost effective method for achieving particular outcomes and a review should be undertaken prior to embarking on a kerbside audit to ensure it is a suitable approach.

The following examples illustrate scenarios which may mean that a kerbside audit of household garden organics bins may not be necessary:

- **Where only the overall generation of garden organics across the LGA is required for the purpose of determining the scale of infrastructure required to process it.** In such a case, weighbridge information can be used to determine overall yearly generation and variations between seasons. It should be recognised that this form of information will not provide an indication of composition or contamination.
- **Where composition and accurate contamination data are not required but individual household generation is, it may be sufficient to only measure net bin weight at the kerbside and not collect the contents of the bin for compositional analysis.** Keep in mind that there will be no way to verify the contents of the household bin so data collected in such a way will provide an indication of gross amounts only.
- **Where the variations in bin composition between households and accurate contamination information is not required**. A simple landfill audit may be sufficient to determine average composition of garden organics coming from across the LGA. Keep in mind that garden organics may come from a variety of sources and not solely from household sources.

If, however councils want to measure individual household generation rates, composition and contamination levels in the garden organics stream and understand the impacts upon generation and composition (e.g. seasonal variations) across the LGA, then kerbside audits of individual bins can be carried out and should be consistent with the methodologies described for residual waste and dry recycling audits.

6.1 Kerbside garden organics audits

In the absence of data derived from trials or previous LGA audits of garden organics which can be used to assist in the calculation of an appropriate sample size, as a starting point, 350 households should be audited per audit and study area to achieve 90% confidence with ±50% uncertainty in the results obtained.

As more data is collected over time through audit processes within any given study area, there will be an opportunity to refine the minimum sample size required for this stream.

The generation of garden organics is strongly influenced by seasonal variation. To understand the importance and influence of seasonal variations, it is recommended that quarterly audits are conducted over a 12 month period to monitor household generation and compositional variations in garden organics. If resources do not allow for quarterly audits, as a minimum, two audits per annum (cyclic sampling) should be undertaken to accurately measure seasonal variation in household organics generation and composition (see Part 5).

The methodology described for sample selection and auditing for residual waste and dry recycling in Parts 3 and 4 of the Guidelines, should be followed when conducting an audit of garden organics.

If combined recycling stream based audits are being undertaken, it is recommended that the same households selected for the dry recycling audit (350 households) are selected for the garden organics audit. This will enhance the overall analysis of the results, see Attachments 3 and 4 – data recording and analysis.

References

Environment Protection Authority NSW (1997) *Waste Stream Data Collection Methodologies Final Draft*, EPA, Sydney.

Klee, A.J. (1993) 'New approaches to estimation of solid waste quantity and composition' in *Journal of Environmental Engineering*, 119, pg. 248-261.

New Zealand Ministry for the Environment (2002) *Solid Waste Analysis Protocol*, Ministry for the Environment, New Zealand.

Singh, N. (2007) '*Report on the Key Issues with 1997 EPA Methodology Review of the Waste Stream Data Collection Methodologies Document - The Domestic Waste Sub-Stream Methodology*'

Statistical Solutions (2007) Methodological Review of the Kerbside Waste Audit, Statistical Solutions, Sydney.

Australian Bureau of Statistics, '*Stratified Sampling*', http://www.abs.gov.au/websitedbs/D3310116.NSF/a91a469056624a32ca256eb000026ca7/116e0f93f17283eb4a2567ac00213517!OpenDocument.

Attachment 1: Planning Checklist

Planning stage

Planning stages provide an opportunity to set the parameters of a study. Central to any planning stage is establishing the purpose of the audit/data collection. For example, is it to provide a 'one off snap shot' of a particular region, or to contribute to time series waste generation data? It is critical that the aim and purpose of any study is clearly defined from the beginning, as this will have implications for the data collection approach adopted and the timing and frequency of audits. The following key steps should be undertaken.

Step 1 – Define the study area

The term **study area** refers to a Local Government Area (LGA) unless otherwise stated.

Step 2 – Collect background information

The following waste management information will be required for the study area:

1. Scale map of the complete study area indicating land use zoning;
2. Domestic waste service collection schedule for the study area and a map indicating all waste disposal and recycling/garden organics collection zones;
3. Location of waste disposal and reprocessing sites serving the study area both inside and outside the study area;
4. Most recent estimates of annual domestic residual waste disposal quantities and recycling/garden organics quantities in tonnes;
5. The type of recycling materials acceptable for kerbside collection;
6. Collection systems in place for residual waste and recycling/garden organics including collection frequencies;
7. Identify key events in the study area which may potentially impact on the waste characteristics of household bins, e.g. a significant local event over an atypical week. Avoid auditing households during such periods; and
8. Obtain details about the types of bins used by households in study areas and their standard net weights. This will be useful for data analysis.

The most recent estimates of waste quantities and recyclables collected should be used for comparative purposes with the figures obtained through an audit.

Step 3 – Select sample locations

Streets and households to be included in an audit should be selected on a random basis. Council rates databases may provide a good means for generating the random selection of households to be included in an audit. At a minimum the analysis of the contents of bins from 260 households is required to produce reliable results about domestic waste quantities and characteristics.

Where audits of recycling or garden organics are being conducted, a minimum of 350 households is required to produce adequate data. It is recommended that sample sizes for recycling/garden organics are checked prior to an audit using regional data if available, however if sufficient data is not available, 350 households will provide a good starting point for auditing this stream.

Over time, sample sizes for domestic residual waste, recycling and garden organics may be adjusted as data sets increase.

Step 4 – Record sampling locations

Details related to sampling locations should be recorded using the reporting structure provided in Attachment 4 as a guide.

Note that residual waste, recyclables and garden organics may be collected on different days. If this is the case, a separate visit will be required to the sampling location site to collect the corresponding materials. Liaison with councils and council contractors to organise interception of the collection service will be required as samples will need to be obtained prior to normal collection service times.

Step 5 – Collect and label samples

It is essential to determine the route, (i.e. the order of picking up the samples) before collection days. Samples should be collected from selected locations just prior to the actual regular collection service. This will minimise the number of potential non presenters as some households may put their bin on the kerbside close to the collection time.

The gross bin weight (bin plus contents) should be weighed at the kerbside to assist with the validation of data pertaining to weights.

The contents of individual household bins must be bagged and clearly labelled identifying the discrete sample number from which the waste is obtained.

To expedite the material collection and sorting process and reduce possible safety concerns, councils may wish to consider collecting household bins and their contents, labelling individual bins to identify ownership (i.e. residential addresses) and providing households with temporary bins while undertaking the audit. Individual household bins can be returned once the audit process is complete.

Councils should also use the opportunity during the audit to undertake a visual assessment of bins presented at the kerbside to ascertain whether the capacity of the bins currently being provided is enough. This can be done by visually recording the fullness of the bin e.g. the volume of the contents of the bin as a percentage of the overall bin volume. This will help councils make decisions about the adequacy of their existing service. It will also assist council with the DECC Annual Waste and Resource Recovery Survey which has a question relating to bin presentation rates at the kerbside and the remaining available capacity of recycling bins within the LGA.

Step 6 – Load the samples and transport to the sorting location

The sample collector must ensure that residual waste and recycling/garden organics materials do not mix and that no spillage occurs in the process of transferring these materials to the sampling vehicle. Occupational Health and Safety standards should be maintained at all times during the process of bagging and loading the contents of individual bins (see Attachment 2).

Step 7 – Prepare the sample sorting area

To undertake waste sorting, a suitable sorting site will need to be selected. Sorting undertaken at a disposal site may reduce the need for additional transportation and handling of waste. The site may also be a council depot or some other dedicated site. While the type and location of a site is not critical, a few basic procedures should be followed:

1. Identify the area where sorting is to be undertaken ensuring it is protected from wind and rain;
2. Remove any unnecessary items from the sample sorting area to achieve a clear working space;
3. Avoid areas where there is likely to be vehicle or pedestrian traffic during the audit; and
4. Ensure appropriate health and safety standards are maintained at all times (see Attachment 2).

Step 8 – Recording of data

The contents and weight of bagged domestic residual waste and recycling/garden organics should be recorded using the reporting structure outlined in Attachments 3 to 5 as a guide. Reporting includes:

- The weight of individual major components within the bagged waste (e.g. plastics and metals);
- The weight of individual minor components within the bagged waste (e.g. hazardous material); and
- The number of individual components identified in the Audit.

A check to ensure all items have been correctly classified in accordance with the Australian Waste Database Material Composition Category codes (AWD-MCC) must be undertaken. This is the required Standard for the collection and reporting of data within New South Wales. Additional material types, such as some hazardous wastes (e.g. gas bottles) that are not classified within the AWD-MCC, should be recorded and reported using the template provided in Attachment 5.

Step 9 – Clean up and decontamination

Given that each sample is to be sorted separately, a clean up phase will be required in order to prepare for the next sample. Appropriately dispose of the previous sample, clean off the sorting table and sweep the area to prevent cross contamination of samples. At regular intervals, ensure sorters Personal Protective Clothing is still suitable for the job, checking for tears in gloves and overalls and replacing respirators/masks as needed. Ensure appropriate Occupational Health and Safety measures are maintained at all times during the clean up and decontamination phase (see Attachment 2).

Step 10 – Data analysis and reporting

The *Reporting Template* outlines a standardised method for reporting data collected through audit studies (see Attachment 4). Data provided to the DECC must be reported using this format. This will enable a consistent approach in the way data is reported.

Enter all data using this data collection template. Materials should be sorted on an individual household basis and recorded under the categories nominated in the template.

Attachment 2: Occupational Health and Safety

There are many potential hazards when sorting wastes such as chemical exposure, fire/explosion, biological and physical risks (from sharp objects including needles, sticks, glass and nails or from the lifting of bins). Awareness of any possible hazards and an Occupational Health and Safety Plan will prevent incidents from occurring. Worker safety is the responsibility of employers, supervisors and workers. Specific plans are needed to reflect specific circumstances, places and times involved in a particular audit.

A Health and Safety Plan covering the manual collection, handling and sorting of materials should be prepared prior to commencement of a waste audit. The aim of the Plan is to prevent the occurrence of injury and/or reduce severity of injuries and require those undertaking audits to identify, assess and control any risks.

The Plan could include the following aspects:

- Identification of personnel undertaking residual waste and resource recovery collection or manual sorting and the implementation of the Pre-employment Screening Program as part of the total Medical Monitoring Program. This program would ensure and monitor each worker's health and fitness; determine the adequacy of worker protection (including shelter from the sun and adequate ventilation); provide emergency and other treatment as needed. Accurate records should be kept for future reference.
- Development of Contingency Safety Plans in case of accidents (e.g. exploding gas cylinder, fire). The Plan would include details of exits, extinguishers, emergency numbers, first aid available and closest hospital.
- A Safety Induction Course for all staff prior to on-site training and carrying out of residual waste and/or recycling and/or garden organics collection or sorting. The course should include hygiene practices (no eating, drinking, or smoking during or after sorting until decontamination is complete); identification of all hazardous materials and their appropriate handling; identification of potential hazards involved in sorting, knowledge of contingency safety plan actions and decontamination procedures.
- Inoculation of all personnel involved in manual waste/recycling/garden organics collection or sorting for Hepatitis-B, Hepatitis-A and Tetanus prior to participating in any waste sorting activities. (Note that vaccination for Hepatitis-A and B may not necessarily result in total immunity. For this reason all members should have their immunity status established by a registered pathologist/medical practitioner prior to sorting waste).
- Appropriate Personal Protection Equipment should be worn/used for the type of residual waste and/or resource recovery material being collected or sorted, e.g. reflective vests, PVC/leather gloves, overalls, goggles/glasses, first aid kit, sharps handling stick and bin, masks, boots, sunscreen, hats (or hard-hat if required), radio/mobile phone, and water bottles. The clothing should be sized to fit the worker.
- Specific needs of the collection and sorting processes should be addressed in the plan, i.e. some site or capital equipment that may reduce the risks of the waste audit include, but are not limited to: weighing scales (small - 0.1 gram intervals, up to 50 kgs and large – up to 150 kgs), mobile garbage bins (240L), bin lifter, trays/buckets, air purifying masks or chemical cartridge respirators, aluminium tongs, working/sorting tables, calculators, data collection/analysis software and PC, cleaning tools and supplies, strong PVC bags and sheets, etc.
- Safe Work Method Statements appropriate to any/all segments of the waste audit.
- Documented accident, incident and hazard investigation reporting procedures.
- Material Safety Data Sheets for any chemicals required, e.g. for cleaning or decontamination purposes.
- Insurance and indemnity details.
- It is also recommended that each audit is assessed to determine any potential barriers to successful completion including identifying risks, availability of qualified personnel, or weather affecting the audit site.

Please note that this is not an Occupational Health and Safety Plan. It merely provides some guidance for the development of such a plan.

It is recommended that auditors comply with the following requirements, which include, but are not limited to:

- Occupational Health and Safety Act 2000 (NSW) and any regulation made under this Act, including the OHS Regulation 2001, as well as any Codes of Practice approved and issued under the above Act and /or regulations made under the Act.
- National Standard for Manual Handling and national code of practice for manual handling, Canberra, AGPS, 1990, National Occupational Health and Safety Commission.
- Health and safety at work; Waste management and recycling industry, WorkCover February 2000.
- Collection of Domestic Waste Code of Practice, WorkCover NSW.
- Occupational Health and Safety (Noise) Regulations.
- Code of Practice for Noise.
- Selection, use and maintenance of Respiratory Protective Devices AS 1715.
- Respiratory Protective Devices AS 1716.
- Industrial safety gloves and mittens AS 2161.
- Use of personal protective equipment of work – a guidance note, WorkCover NSW.
- Skin cancer and outdoor workers: a guide for employers, WorkCover NSW.
- Skin cancer and outdoor workers: a guide for workers, WorkCover NSW.
- Code of practice: HIV and other blood-borne pathogens in the workplace, WorkCover NSW.
- Guidelines for record keeping at a solid waste processing plant, ASTM E1076 Standard Practice for Maintaining Health and Safety Records at Solid Waste Processing Facilities, which includes items such as personal and work history records, health records, accident records, work environment records, occupational safety records.
- Procedures for air monitoring based on ASTM D4544, Standard Guide for Air Monitoring at Waste Management Facilities for Worker Protection. The air quality should follow guidelines as stated in the Exposure Standards for Atmospheric Contaminants in the Occupational Environment, Work Safe Australia 1991.

Additional material is periodically released by health and safety authorities. Check the latest advice *prior to undertaking an audit for the latest material.*

WorkCover NSW
Phone 13 10 50
www.workcover.nsw.gov.au

Other relevant information includes the Government of South Australia's *Waste Auditing – a Health and Safely Guide:*
http://www.zerowaste.sa.gov.au/pdf/kerbside/kerbside_waste_auditing.pdf

Attachment 3: Reporting Audit Data and Preparing a Domestic Kerbside Waste Stream Audit Report

Data Collection

The collection of robust and reliable data requires the collaboration of a range of stakeholders. In measuring household waste quantities and characteristics at a local level, the following key roles and responsibilities have been identified:

- The DECC provides waste audit methodologies and guidance based on robust statistical analysis and in consultation with key users and stakeholders;
- Parties including councils and waste auditing contractors conduct waste stream kerbside audit data collections;
- Raw data is provided to DECC;
- DECC analyses the information provided from the audits in collaboration with the relevant parties and will report:
  - regional and state-wide data on minor components of domestic residual waste and resource recovery streams.
  - regional and state-wide data on all major components of domestic residual waste and resource recovery streams.
- The DECC will use the data to assist Performance reporting against NSW Waste Strategy targets and outcome areas, which is prepared every 2 years;
- The DECC, councils and other organisations use the data to inform policy and program decisions.

Attachment 4 represents a format which can be used by councils preparing an Audit Report for their internal reporting requirements.

For councils reporting data to the DECC, the Reporting Template format in Attachment 4 should be used as a guide to analysing and reporting data.

The DECC requires that copies of raw data sheets from individual and/or multiple households be attached to the report in MS Excel format.

The following Excel Reporting Data Sheets are provided on the DECC website at www.environment.nsw.gov.au and on the accompanying CD.

(i) Raw Data Sheet – Individual Bins (also Attachment 5)

(ii) Raw Data Sheet – Multiple Bins

(iii) Raw Data Sheet – MUD Developments

An electronic copy of the audit report, formatted in MS Word, along with all Excel raw data spreadsheets and Excel analysis spreadsheets should be forward to DECC's Data Team at the completion of the audit (see contact details following).

The Report Template is provided as a guide to the format and level of data analysis and presentation that should be included in the Audit Report provided to DECC. It is by no means comprehensive and the inclusion of additional analysis in the Report is encouraged.

Data Recording and Analysis:

- Data should be collected separately for each waste stream under consideration (Residual Waste, Recycling, Organics) and recorded on a Raw Data Sheet template.
- Materials should be sorted into the various categories, using the Material Type and Material Items (Attachment 6) for sorting and measuring some items to be counted.
- The Excel spreadsheet in Attchment 5 (Individual bins) and/or Data Sheet for Multiple Bins (DECC website and CD) should be provided to DECC with the Report.
- Some individual items need to be counted together with a weight value. Counted items are listed in Attachment 5, Table A3.2.
- The Australian Waste Database (AWD) provides the codes used to classify a material. The AWD provides a national solid waste and hazardous waste classification system, and searchable database of solid waste information for Australia.

Contact Details:
spddata@environment.nsw.gov.au

DATA UNIT
Department of Environment and Climate Change NSW
Sustainability Programs Division

PO BOX 513
WOLLONGONG
NSW 2500

Attachment 4: Report Template

Domestic Kerbside Waste Stream Audit

for

[Council Name]

[Month YEAR]

AUDIT UNDERTAKEN BY

Name:

Address:

Phone:

Fax:

Email:

Disclaimer:

Acknowledgements:

Table of Contents

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Glossary

Executive Summary

Background

Council's Kerbside

Domestic Waste Stream Audit was conducted by Name of Auditor during Month / Year.

Purpose of audit (Domestic residual waste / recycling / garden organics were examined to determine):

- ……
- ……..
- ……

Outline methods for the collection of data

(e.g. Audit Plan / Timeframe / OH&S / Staff etc)

Summary of key results

Introduction

Purpose

1. Outline the purpose of this audit. For example was it:
   - To provide a one off snap shot on the state of household residual waste, resource recovery quantities and bin composition
   - To contribute to time series data
   - To measure socio-economic impacts upon overall waste generation and bin composition
   - To assist in determining overall domestic waste generation figures for the area.
2. Outline audit approach forming the basis of audit (i.e. Single Snap Shot Audit approach / Audit to contribute to Quarterly Sampling approach / Audit to contribute to Cyclic Sampling approach / Audit to contribute to Rotational 4 Year Sampling).

Background

Provide background information on the following:

- Residential Dwellings, Single Unit dwellings (SUDs) / Multi Unit dwellings (MUDs), Rural / Urban, % mix difference in area, seasonal variation.
- About the Council, waste management systems, bin sizes, collection frequency.
- Previous audits – when, where, why, what?
- Anything else known about waste stream systems? – Contractors, frequency etc.

Project Objectives

For an initial (first) audit:

A waste stream audit aims to:

Examples:

- Provide benchmark data to assist in developing knowledge of domestic generation and composition for the following collection systems:
  - Kerbside domestic/residual waste bin and/or
  - Kerbside recycling bin and/or
  - Kerbside garden organics bin
- Assess data to develop knowledge of household generation rates for domestic residual waste and/or recycling and/or garden organics and compare with state averages
- Quantify and characterise the quantity and type of materials located in the domestic waste stream that can be recovered
- Quantify and characterise the contamination in the recycling and garden organics streams
- Highlight potential household waste reduction strategies.

For a follow-up (second) audit:

A waste audit aims to:

Examples:

- Identify seasonal variation in waste generation.
- Measure the degree of improvement in household waste management and resource recovery since the previous audit.
- Assess the effectiveness of the current kerbside waste management and resource recovery systems compared to any previous systems.
- Highlight and recommend opportunities for further waste reduction if identified.
- Provide an opportunity to promote the household waste management and resource recovery systems if they have been identified as having achieved significant waste reduction and greater resource recovery.
- Provide data to assist in developing knowledge of household generation and composition for the following collection systems
  - Kerbside domestic/residual bin and/or
  - Kerbside recycling bin and/or
  - Kerbside garden organics bin.
- Quantify and characterise the level and extent of contamination in the recycling and garden organics streams.

Audit Methodology

Sample Selection

For each stream:

1. Outline procedures for determining the size and selection of the sample. Provide details relating to the sampling framework used to collect household audit data, e.g. Simple Random Sampling, Stratification Sampling etc., and outline rationale for any deviation from the sampling procedures described in the Guidelines. Also describe the household selection process.

> ***The Guidelines state that if previous audit data is available to councils a refinement of the minimum sample sizes can be undertaken, providing that this refinement is based on a minimum 90% confidence with ±10% uncertainty for residual waste and 90% confidence with ±50% uncertainty for recycling and/or Garden Organics.***

2. Explain how households were selected. Note the time of the year, season and any special events that may have taken place or any unusual circumstance surrounding the audit, e.g. a) Annual garden clean up may have contributed to the large proportion of garden organics noted during the study; b) Unusually busy weekend because of local event / festival etc.

Provide a table in the Appendices detailing the location, dwelling type, stream, and collection timeframe for all samples.

Example of table summarizing sample collection information

House No.	Street / Suburb	Waste / Stream	Day	Collection Date	Bin Size	Collection Timeframe (i.e. Weekly / Fortnightly)	Dwelling Type
X St		Waste	Tue	20/2/07	240l	Weekly	SUDs
						Fortnight	MUDs
							Rural

Material Collection Strategy

1. Outline the material collection strategy used. This might include details about:

   a. The contractor engaged to collect material (if applicable).

   b. The material collection process, including methods used to collect and bag bin contents e.g. the process involved the collection of all bins and their contents and the distribution of temporary bins to households during the audit process.

   c. Replacement or substitute households and their inclusion in the audit.

   d. How damaged bins were dealt with.

Sorting

Describe sorting process. This might include details about:

a. Location for sorting

b. Staffing

c. Timeframe for sorting etc.

Occupational Health and Safety

Outline Occupational Health and Safety plan. This might include details about:

a. Risk assessment

b. The training and induction of staff

c. Personal Protective Gear etc.

Confidentiality

Provide copies of any signed Memorandum of Understanding and Confidentiality agreements. Briefly summarise strategy for handling and maintaining privacy of information collected through household audit process.

Disposal of Sorted Material

Provide details of disposal strategy for material collected and analysed as a part of the household audit process.

Data Verification and Accuracy

Provide details of how data accuracy was determined and verified. Examples of methods for ensuring data accuracy are:

- Reconciliation of overall sample weight by comparing bin net weight at the kerbside to the sum of the individual component weights. It is recommended that, as a minimum, apparent data entry errors of 10% or greater be investigated.
- Have the lead auditor or alternate auditors re-measure a percentage of all samples.

Results

Waste Stream Analysis

Present and analyse waste stream data analysis under the following headings. Suggested graphical representations of the data are also provided:

Household generation and the composition of household bins – How to handle non presenters and replacement bins.

Analysis

In the event a household bin is not presented at the kerbside, this household should be classified as a 'non presenter' with a zero (0) recorded on the data sheet to signify this.

Due to logistical issues, it is suggested that Councils may go to the neighbouring household, bagging and analysing the contents of their bin, in order to account for the required number of households per audit (i.e. 260 domestic waste/ 350 recycling/ 350 garden organics). In the event this happens, these households should be recorded as a 'replacement' or 'substitute'.

Data collectors need to be aware that the analysis of data collected from 'non presenters' and 'replacements/substitutes' requires a different approach.

DO'S AND DON'TS

For analysing the composition of household bins, it is fine for data collectors to include replacement or substitute household bin data in the analysis to determine composition.

However, for determining household generation rates, analysis should exclude data collected from replacement or substitute households (bins). The inclusion of replacement or substitute bin data, will provide an inaccurate measure of household generation rates, potentially skewing results.

To determine household generation, data collected from 'non presenters' should be included. This means that zeros will be counted in the analysis. The inclusion of 'non presenters' will provide a more statistically accurate means to measure household generation per study area.

Household generation and the composition of household bins – How to handle damaged bins.

Analysis of data collected from damaged bins requires a different approach. A damaged bin may indicate that the contents have been exposed to the elements, especially rain. This may result in the overall weight of the bin, and the weight of particular items within it, being affected. Also it is difficult to determine whether or not such an event has occurred and the following approach is recommended:

1. If only a few bins in the sample are affected in this way then the sample data should be recorded and analysis carried out as if the bin is intact.
2. Include a note with the analysis that the overall result may be influenced by the affected bin(s).
3. If a severe weather event has caused damage or may have affected the weight or composition of a large proportion of bins in the sample then it may be prudent to delay the audit until the next corresponding collection cycle.

Domestic Residual Waste Stream

Presentation rate

a. Determine Mean (average) Household Presentation Rate based on the number of bins presented at the kerbside divided by the total sample. Presentation rate should be based on the number of bins present in the original sample and not include substitute bin data.

$$\text{Presentation Rate} = \frac{\text{No. of households with bins presented x 100\%}}{\text{Total sample size } (n)}$$

(n) Number of households

Household generation

b. By weight (Note: Non-presenters should be included in calculations and substitutes or replacements excluded).

i. Calculate
- Median household bin weight
- Mean (Average) household bin weight

ii. Analyse variation in generation on a household basis (calculate standard deviation etc.)

iii. Determine Household Gross Yield (kg per household per week)

iv. Extrapolate household waste generation rate for whole of LGA i.e. Total tonnes generated per annum

Note:
Overall generation data calculated by this method should be used as a guide only for those councils who do not have a weighbridge at their landfill or transfer station facilities. Councils that have a weighbridge should rely and report on weighbridge information to determine overall domestic waste generation across the LGA:

c. Bin volumes (if measured).

Calculate
- Median household bin volume
- Mean (Average) household bin volume

Composition of household bin (expressed in % by Weight)

d. Quantities of individual components present in a residual waste stream. *(This can be done by using all household bins presented and additional bins used to make up numbers i.e. from substitute or replacement households).*

i. Mean (Average) Composition of the total Residual Waste Stream (individual components – Table only)

ii. Mean (Average) Composition of the Residual Waste Stream (broad components – Table and Graph)

iii. Analyse variation in composition on a household basis (calculate standard deviation) for broader categories

iv. Average Composition of the total Residual Waste Stream (Non-recyclables versus Potential Recyclables – Table and Graph)

v. Potential Recyclables in the Residual Waste Stream (broad components by Area – Table and Graph)

Figure 1: An example of Composition of the Waste Stream (% Weight)

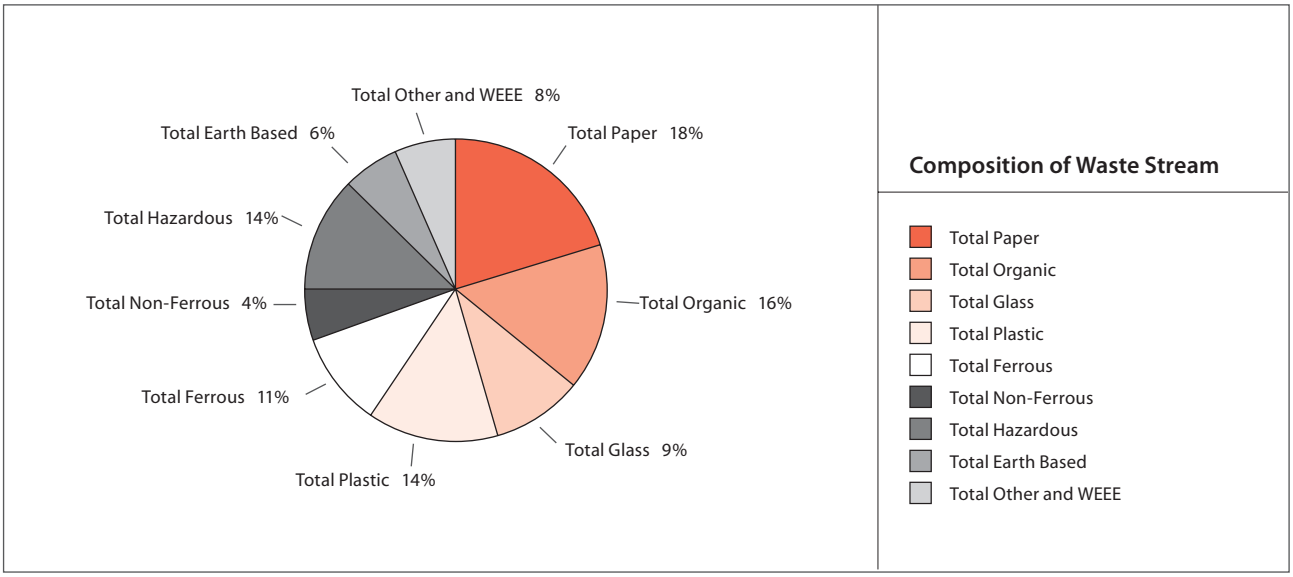
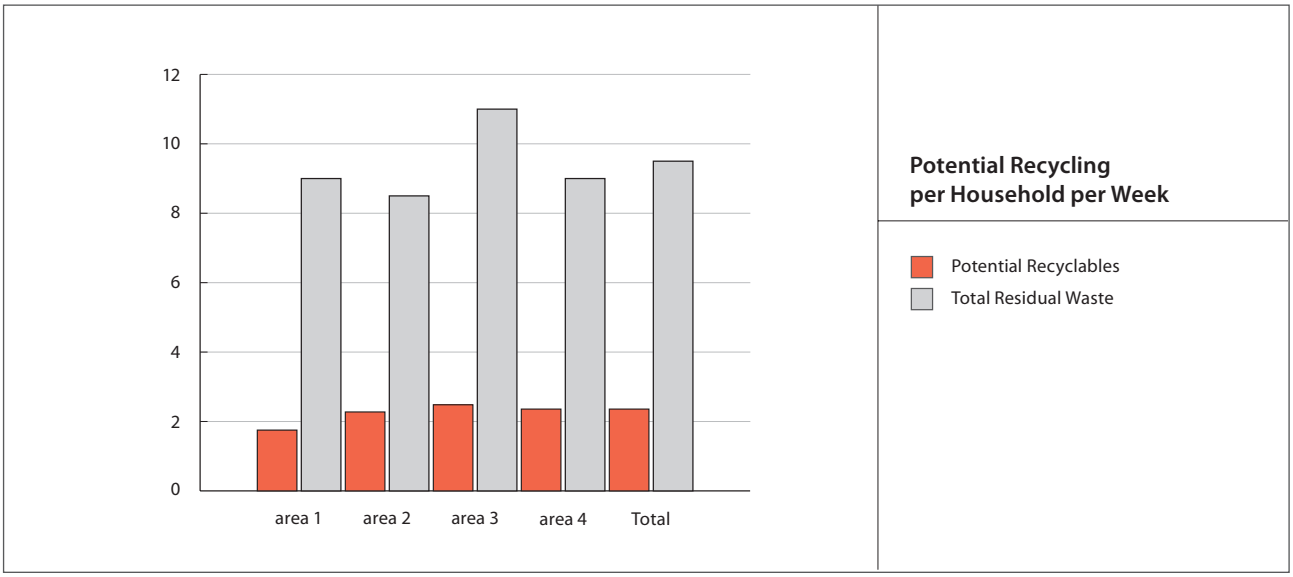


Figure 2: An example of Potential Recycling per Household per Week



Domestic Kerbside Dry Recycling Stream

Presentation rate

e. Determine Mean (average) Household Presentation Rate based on the number of bins presented at the kerbside divided by the total sample. Presentation rate should be based on the number of bin present in the original sample and not include substitute bins.

$$\text{Presentation Rate} = \frac{\text{No. of households with bins presented x 100\%}}{\text{Total sample size } (n)}$$

(n) Number of households

Household generation

f. By weight (Note: Non-presenters should be included in calculations and substitutes and replacements excluded).

i. Calculate
   - Mean (Average)median and average household bin weights
   - Median (Average) household bin weight

ii. Analyse variation in generation on a household basis (calculate standard deviation etc.)

iii. Determine Household Gross Yield (kg per household per week)

iv. Extrapolate household recycling generation rate for whole of LGA i.e. Total tonnes generated per annum

g. Bin volumes (if measured).

Calculate
   - Median household bin volume
   - Mean (Average) household bin volume

Composition of household bin (expressed in % by Weight)

h. Quantities of individual components present in the Dry Recycling stream (This can be done by using all bins presented and substitute or replacement bins from households used to make up numbers for non-presenters). Report on the following:

i. Mean (Average) Composition of the total Dry Recycling stream (individual components – Table only)

ii. Mean (Average) Composition of the Dry Recycling stream (broad components – Table and Graph)

iii. Average Composition of the total Dry Recycling stream (recyclables versus contamination – Table and Graph)

Figure 3: An example of Composition of contamination in the Dry Recycling Stream (% Weight)

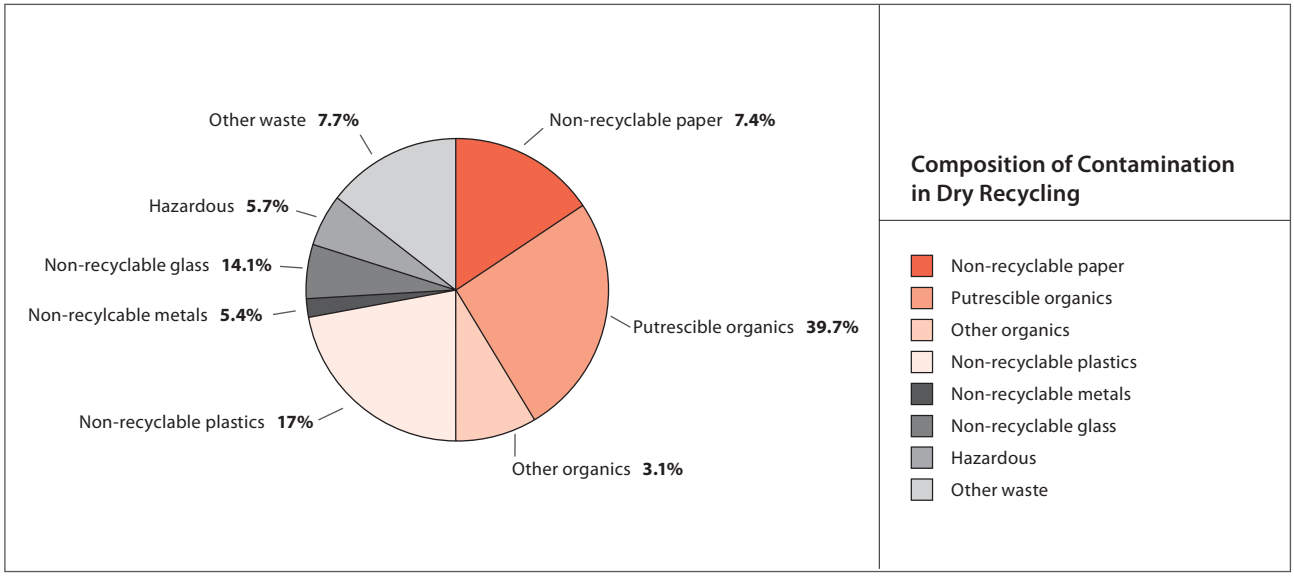
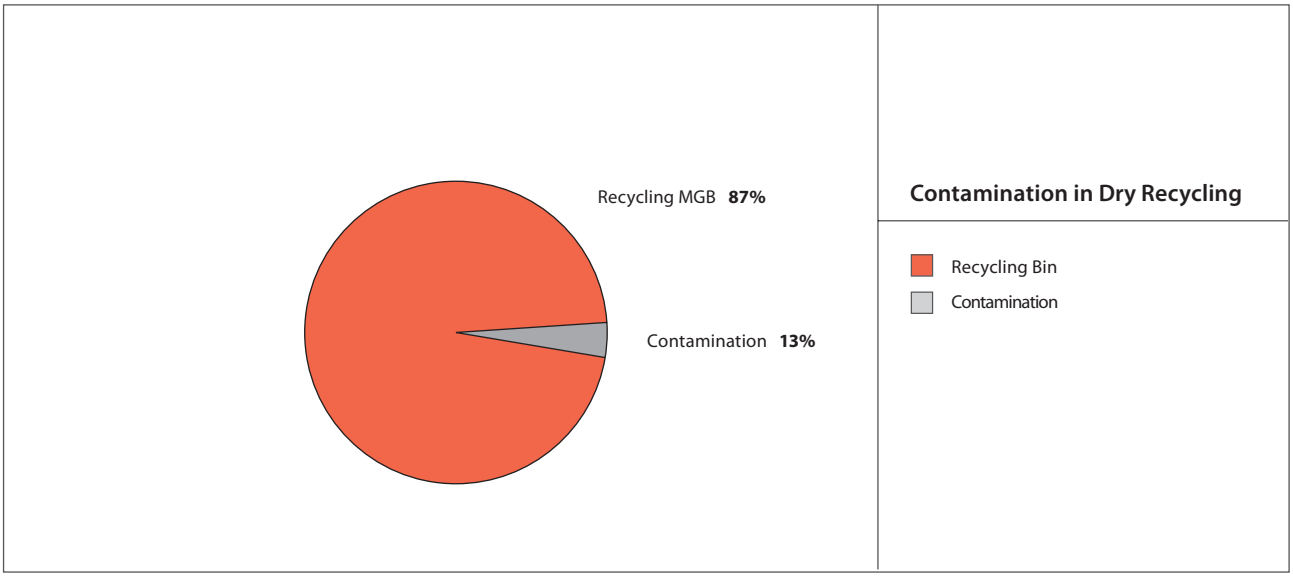


Figure 4: An example of Contamination in the Dry Recycling Stream



Domestic Kerbside Organics Recycling Stream

Presentation rate

i. Determine Mean (average) Household Presentation Rate based on the number of bins presented at the kerbside divided by the total sample. Presentation rate should be based on the number of bins present in the original sample and not include substitute bins.

$$\text{Presentation Rate} = \frac{\text{No. of households with bins presented} \times 100\%}{\text{Total sample size } (n)}$$

(n) Number of households

Household generation

j. By weight (Note: Non-presenters should be included in calculations and substitutes and replacements excluded).

i. Calculate

- Mean (Average) household MGB weight
- Median household bin weight

ii. Analyse variation in generation on a household basis (calculate standard deviation etc.)

iii. Determine Household Gross Yield (kg per household per week)

iv. Whole of LGA total tonnes generated per annum

Composition of household bin (expressed in % by Weight)

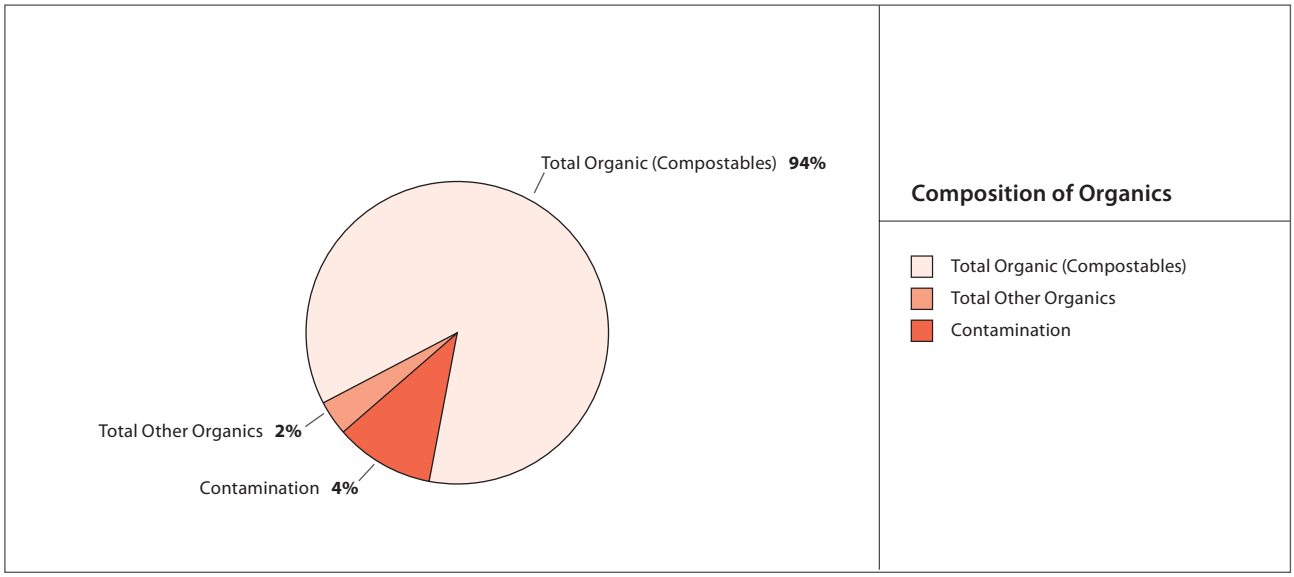
k. Quantities of individual components present in the Garden Organics stream. *(This can be done by using all bins presented and substitute or replacement bins from households used to make up numbers for non-presenters).* Report on the following:

i. Average Composition of the total Garden Organics stream (individual components – Table only)

ii. Average Composition of the Garden Organics stream (broad components – Table and Graph)

iii. Average Composition of the total Garden Organics stream (recyclables versus contamination – Table and Graph)

Figure 5: An example of Composition of Organics in the Waste Stream



Overall Domestic Kerbside Waste Stream

Household generation

l. By weight (Note: Non-presenters should be included in calculations and substitutes or replacements excluded).

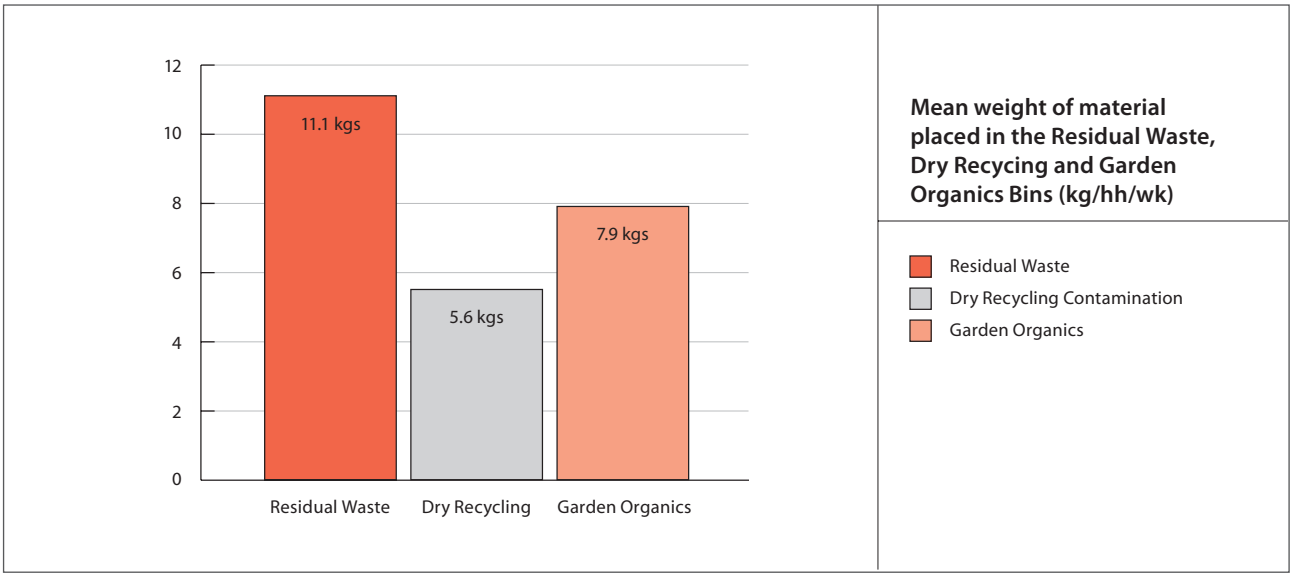
i. Calculate

- Mean (Average) household MGB weight
- Median household MGB weight

ii. Analyse variation in generation on a household basis (calculate standard deviation etc)

iii. Determine Household Gross Yield (kg per household per week)

Figure 6: An example of Average weight per Week by Waste Stream



Composition of household bin (expressed in % by Weight)

m. Quantities of individual components present in the Garden Organics stream. *(This can be done by using all bins presented and substitute or replacements bins from households used to make up numbers for non-presenters).* Report on the following:

i. Average Composition of the total waste stream i.e. Waste + Recycling (individual components – Table and Graph of broader components)

ii. Average Composition of the total waste stream (broad components – Table and Graph)

iii. Composition of total waste stream by sample Areas (broad components – Table and Graph)

Figure 7: An example of Total Domestic Kerbside Waste Stream – Composition (Weight%)

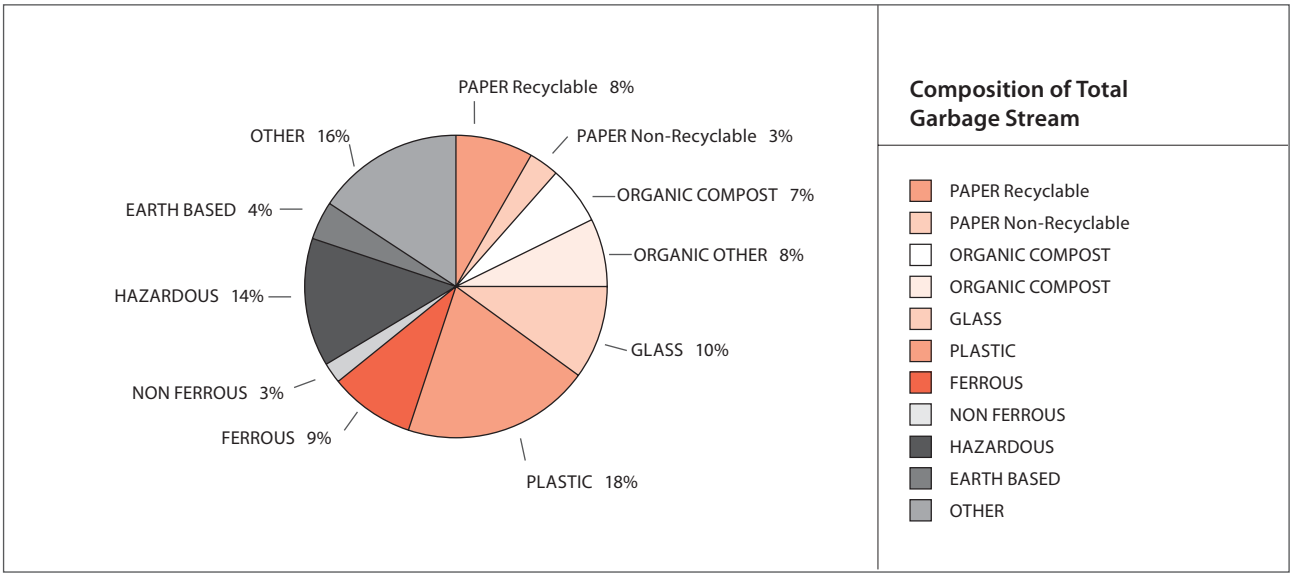


Figure 8: An example of Composition (Weight%) – Total Domestic Kerbside Waste Stream

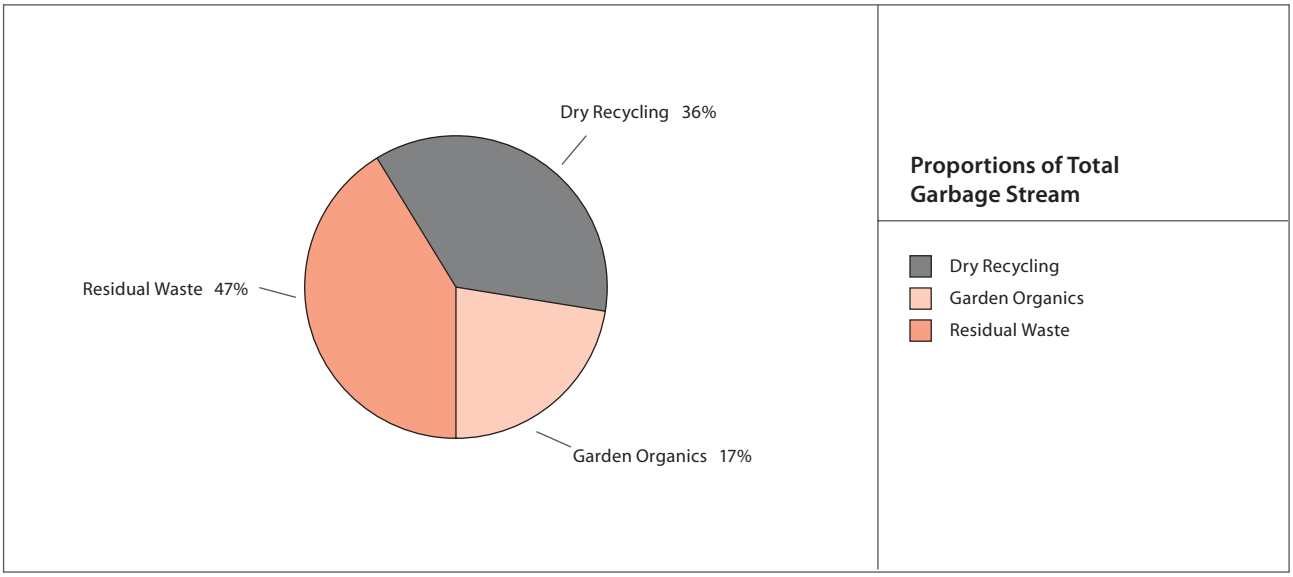
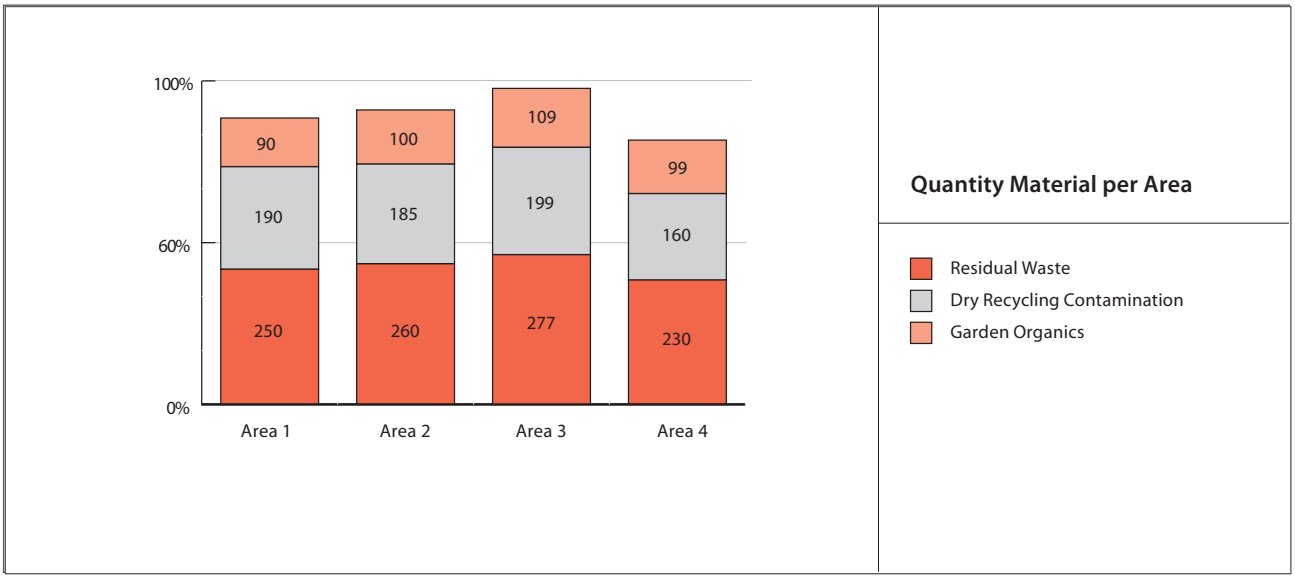


Figure 9: An example of Composition per Sample Area (Weight %) – Total Domestic Kerbside Waste Stream



Household Kerbside Diversion Rate

The Household Kerbside Diversion Rate is the total amount of materials disposed of by households that is recovered for recycling or reprocessing and can be calculated where audits of the Residual Waste, Dry Recycling and Garden Organics have been undertaken for the same household. It does not include clean-up collections, loose vegetation collections and drop off systems.

$$\text{Household Kerbside Diversion Rate} = \frac{\text{Weight of materials in the recycling/organics bins}}{\text{(Weight of materials in garbage bins + recycling bins + garden organics bins)}} \times 100$$

Resource Recovery Rates

(Only applicable to combined Residual Waste, Recycling and Organics Audits)

Recovery rates may also be determined for individual materials or groups of materials within each waste stream where a comprehensive or whole of system audit is undertaken. Recovery rate is the percentage of materials (or a material type) consumed by the household(s) that is recovered for recycling or reprocessing.

Overall Recycling Recovery Rate

$$\text{Recovery rate} = \frac{\text{Recyclables and organics in the recycling bins}}{\text{(recycling (or organics) in the garbage bins + recycling in the recycling bins)}} \times 100$$

Garden Organics Recovery Rate

$$\text{Recovery rate} = \frac{\text{garden organics in the garden organics bins}}{\text{(garden organic in the garbage bins + garden organics in the garden organics bins)}} \times 100$$

Figure 10: An example of Individual Household Kerbside Recovery Rates

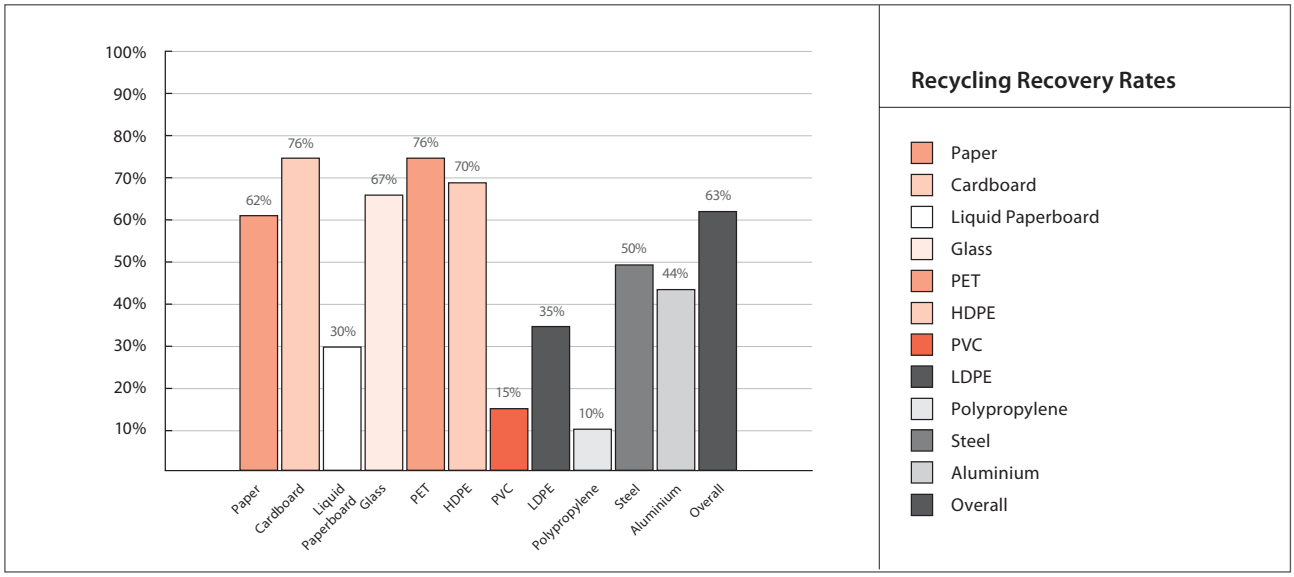
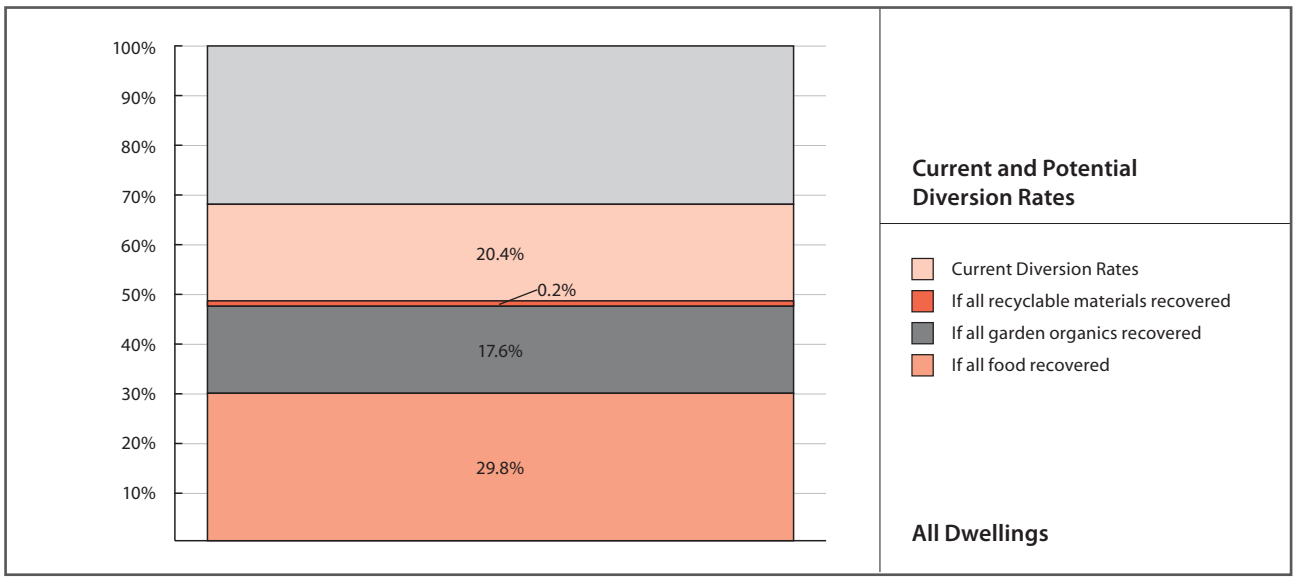


Figure 11: An example of Current and Potential Diversion Rates



Comparison with past audit data

If this is a follow-up (second) audit:

i. Compare household generation (for either domestic waste and/or recycling and/or garden organics) between audits

ii. Compare estimates of total waste to landfill and total recycling for LGA between audits

iii. Compare household waste and recycling bin compositions

iv. For broad categories determine waste types eliminated from waste stream and now recycled

v. Include time series data if available - discuss contamination and recovery rates over time

vi. Discuss changes, other factors, trend data

Additional Analysis

The above analysis relates to audits carried out at the LGA level and does not take into account audits expanded to account for variations in household waste generation, recovery and bin composition based on seasonal and socio-economic differences within the LGA. When these factors are investigated the above template can be used to guide this expanded analysis.

Issues

Issues with the Waste Audit:

- Waste audit procedure
- Waste management area / equipment
- Significant / unusual waste types / weather
- Any other issues relevant to the methodology, data collection or results
- Significant Non Presentation of bins which may detract from results.

Photos

Include photos where possible. For example:

- Waste audit procedure
- Waste management area / equipment
- Significant / unusual waste types
- Any other photos relevant to report.

The Future

- Explain any further audits planned
- Discuss any recommendations / opportunities.

Conclusion

Summarise the information already presented; the section should not contain any new information.

Cover:

- Project Objectives met
- Audit Methodology followed
- Waste and resource recovery statistics gathered during audit
- Key Findings
- Residual Waste and Resource Recovery Challenges – what needs to be improved, Future involvement - planned follow-up audit.

Attachment 5: Raw Data Sheet – Individual Bin

Table A3.1 Raw data sheet for individual bins [Note: DECC has provided the Raw Data spreadsheet in MS Excel format which can be downloaded from www.environment.nsw.gov.au

LGA	
ABS Code	
Dwelling Reference Number (MUDs only)	

Collection Time (by auditor)		Normal Collection Time (by truck)	
Collection Date (by auditor)		Normal Collection Time (by truck)	
Sorted by			
Weather conditions (on collection day)			

Sample/Bin Number	
Dwelling Type (MUD/SUD)	
Waste Stream	
No. Collections per week	
Was this a Substitute Bin (Y/N)	
Bin Type	
Bin Size	
No Units serviced by this bin (MUDs only)	
Bin Weight (before emptying) (Kg)	
Standard Bin Weight (Kg)	
Net Bin weight (Kg)	
% Full by Volume	
Overall comments on bin	

AWD	MATERIAL	Weight (kg)	Comments
	PAPER		
A01	Newspaper		
A02	Magazines/Brochures		
A03	Miscellaneous Packaging		
A04	Corrugated Cardboard		
A05	Package Board		
A06	Liquid Paper Containers		
A07	Disposable Paper Product		
A08	Print/ Writing/ Office Paper		
Total	***Recyclable Paper***	***0.00***	
A09	Composite (mainly paper)		
A90	Nappies Disposable		
A092	Contaminated Soiled Paper		
Total	***Non Recyclable (Composite)***	**0.00**	
	Total Paper	**0.00**	

	ORGANIC (Compost)		
B01	Food / Kitchen		
B02	Garden / Vegetation		
B03	Other Putrescible		
Total	***Organic (Compostables)***	***0.00***	
	OTHER ORGANIC		
C01	Wood / Timber		
C02	Textile / Rags		
C03	Leather		
C04	Rubber		
C05	Oils		
Total	***Other Organics***	**0.00**	
	Total Organic	**0.00**	
	GLASS		
D01	Packaging / Glass Containers		
D0121	Packaging / Cullet White		
D0122	Packaging / Cullet Green		
D0123	Packaging / Cullet Brown		
Total	***Glass Packaging***	**0.00**	
D050	Mixed Glass / Fines		
D02	Miscellaneous / Other Glass		
Total	***Glass Fines Other***	**0.00**	
	Total Glass	**0.00**	
	PLASTIC		
E01	PET		
E02	HDPE		
E03	PVC		
E04	LDPE		
E05	Polypropylene		
E06	Polystyrene		
E07	Other Plastic		
E071	Foams		
E072	Plastic Bags		
E073	Film		
E08	Composite (mostly plastic)		
	Total Plastic	**0.00**	
	FERROUS		
F01	Steel Food and Pet Cans		
F011	Steel Aerosols		
F012	Steel Paint Cans		
Total	***Steel Packaging***	**0.00**	
F03	Composite (mostly ferrous)		
F02	Other (specify)		
Total	***Other Steel***	**0.00**	
	Total Ferrous	**0.00**	

	NON FERROUS		
G01	Aluminium (Cans and Foil)		
Total	***Aluminium Packaging***	**0.00**	
G03	Composite (mostly non-ferrous)		
G02	Other (specify)		
Total	***Other Non Ferrous***	**0.00**	
	Total Non-Ferrous	**0.00**	
	HAZARDOUS		
H01	Paint		
H02	Fluorescent Tubes *		
H03	Dry Cell Batteries *		
H04	Car Batteries *		
H05	Household Chemicals		
H06	Asbestos/Building Materials		
H07	Pathogenic Infectious		
	Gas Bottles *		
	Hazardous Other		
	Total Hazardous	**0.00**	
	EARTH BASED		
I01	Ceramics		
I02	Dust / Dirt / Rock / Inert		
I03	Ash / Earth Based Other		
	Total Earth Based	**0.00**	
	OTHER		
Q53	Other Household Items		
Y57	Toner Cartridges *		
	Computer Equipment *		
	Mobile Phones *		
	Electrical Items *		
XX00	Other (specify)		
	Total Other and WEEE	**0.00**	
	Total Weight of Individual Materials	**0.00**	
	Net Bin Weight - Total Individual Weight	**0.00**	

Note * Items to be counted along with total weight

Table A3.2

AWD	MATERIAL	Count	Comments
H02	Fluorescent Tubes		
H03	Dry Cell Batteries		
H04	Car Batteries		
	Gas Bottles		
Y57	Toner Cartridges		
	Computer Equipment		
	Mobile Phones		
	Electrical Items		Small Electrical( ) Power Tools ( ) DVD/VCR ( ) TVs( )

Attachment 6: Examples by Material Type and Material Items

AWD Code	Material Type	Material Items
	PAPER	
A01	Newspaper	Newspapers, newspaper like pamphlets
A02	Magazines / Brochures	Magazines (glossy and non-glossy), pamphlets,
A03	Miscellaneous Packaging	Wrapping paper, Labels, Paper packaging (no plastic or wax coatings)
A04	Corrugated Cardboard	Cardboard with corrugation
A05	Package Board	Cardboard without corrugation (glossy and non glossy), cereal boxes, business cards
A06	Liquid Paper Containers	Soy milk cartons, some fruit juice cartons, UHT / Long life milk,
A07	Disposable Paper Product	Hand towels, tissues, coffee cups, paper napkins, paper food bags (unsoiled)
A08	Print / Writing Office Paper	A4 document paper, writing pads, letters, envelopes, books
A09	Composite (mostly paper)	Composite paper items where the weight of the paper is estimated to be greater than the weight of the other materials
A90	Nappies	Used disposable nappies
A092	Contaminated Soiled Paper	Paper not suitable for recycling, mixed and other paper, used tissues, soiled paper
	ORGANIC (COMPOSTABLES)	
B01	Food / Kitchen	Vegetable scraps, meat scraps, animal food, left over food.
B02	Garden / Vegetation	Grass clippings, tree trimmings / prunings, flowers, tree wood (<20mm)
B03	Other Putrescible	Animal excrement, mixed compostable items, cellophane
	OTHER ORGANIC	
C01	Wood / Timber	Milled wood / timber, children's wooden toys, wooden skewers, garden tree (>20mm)
C02	Textile / Rags / Carpet (Organic)	Wool, cotton and natural fibre materials
C03	Leather	Leather clothing, craft leather, some shoes, belts with belt buckle
C04	Rubber	Rubber bands, rubber toys, shoes, latex gloves
C05	Oils	Used car oil, motor and other, vegetable, cooking oil
	GLASS	
D01	Recyclable Glass	Beer bottles, wine bottles, food and sauce jars other than clear, green or brown
D0121	Glass Packaging / Containers Clear	Beer bottles, wine bottles, food and sauce jars (clear glass)
D0122	Glass Packaging / Containers Green	Beer bottles, wine bottles, food and sauce jars (green glass)
D0123	Glass Packaging / Containers Brown/Blue	Beer bottles, wine bottles, food and sauce jars (amber/brown glass)
D050	Mixed Glass / Fines	Mixed Glass or Glass fines <4.75mm - non recyclable
D02	Miscellaneous / Other Glass	Plate glass (window and windscreen), Pyrex, corning ware, light globes, laboratory and medical glass, white opaque glass (e.g Malibu alcohol bottles),
	PLASTIC	
E01	PET #1	(Polyethylene) Soft drink bottles, juice bottles, some food containers (e.g. jam and sauce bottles), mouthwash containers, peanut butter jars,
E02	HDPE #2 (High Density Polyethylene)	Milk and cream bottles, shampoo and cleaner bottles,

E03	PVC #3 (Polyvinyl Chloride)	Clear cordial and juice bottles, blister packs, plumbing pipes and fittings
E04	LDPE #4 (Low Density Polyethylene)	Ice cream container lids, cream bottle lids, squeeze bottles, lids, poly pipe, black mulch film, plant nursery bags, builders black plastic, bread bags,
E05	Polypropylene #5 (Polypropylene)	Ice cream containers, drinking straws, plant pots, some bottle caps, microwave oven ware, plastic garden settings, potato crisp bags, compost bins, worm farms
E06	Polystyrene #6 (Polystyrene and expanded polystyrene)	Yoghurt / sour cream containers, plastic cutlery, imitation crystal glassware, clothes pegs, coat hangers, office accessories, video/CD boxes, hot drink cups, take away containers, meat trays, packaging foam
E07	Other Plastic	Tupperware, mixed unidentifiable plastics, low cost brittle toys, all other resins and multi-blend plastic materials, synthetic textiles, all other containers.
E071	Foams	Foam
E072	Plastic Bags	Plastic shopping bags
E073	Film	Film, office film, cling film
E08	Composite (mostly plastic)	Cigarette butts, composite plastic items where the weight of the plastic is estimated to be greater than the other material items.
	FERROUS	
F01	Steel Packaging Food and Pet Cans	Food cans, pet food cans, tins,
F011	Steel Aerosols	Aerosol cans
F012	Steel Paint Cans	Empty paint tins
F03	Composite (mostly ferrous)	Beer bottle tops, jar lids, composite ferrous items where the weight of the ferrous metal is estimated to be greater than the other material items.
F02	Other (specify)	100% ferrous items that are not cans / tins / packaging materials, any other steel.
	NON-FERROUS	
G01	Aluminium	Beer and soft drink cans, clean foil
G03	Composite (mostly non-ferrous)	Composite non-ferrous metal items where the weight of the metal is estimated to be greater than the other material items.
G02	Other (specify)	Copper / brass / bronze items, other metals (not ferrous / aluminium)
	HAZARDOUS	
H01	Paint	Paint (dry or wet)
H02	Fluorescent Tubes	Fluorescent tubes; compact fluorescent lamps (CFLs)
H03	Dry Cell Batteries	Common batteries, AAA, AA etc, single use or rechargeable
H04	Car Batteries	Car batteries
H05	Household Chemicals	Bleach, shampoo, cleaning products, unused medical pills
H06	Asbestos / Building Materials	Asbestos or building materials not earth based or wood
H07	Clinical (Medical)	Sharps, human tissue, bulk bodily fluids and blood, any blood stained disposable material or equipment.
	Gas Bottles	Gas bottles
	Hazardous Other	Any other hazardous material,
	EARTH BASED	
I01	Ceramics	Cups, bowls, pottery items
I02	Dust / Dirt / Rock / Inert	Vacuum bag contents, soil, rocks, dirt, concrete, plasterboard
I03	Ash / Earth Based	Ash

	OTHER AND WEEE	
Q53	Other Household Items	Other Household Items, candles, candle wax, cosmetics
Y57	Toner Cartridges	Printer and toner cartridges
	Computer Parts	Keyboard, monitor, cables, printers etc
	Electrical Items	Toaster, radio, Ipod, gameboys, stereos, speakers, TVs, VCR, DVD players, small electrical, power tools, wiring and cables.
	Mobile Phones	Mobile Phones
XX00	Other	Other please specify

Attachment 7: Key Issues with 1997 EPA Methodology

Extract from:
***Singh, N. 2007*. 'Report on the Key Issues with 1997 EPA Methodology Review of the Waste Stream Data Collection Methodologies Document- The Domestic Waste Sub-Stream Methodology'.**

"The sampling methodology in the EPA 1997 document as it stands may not necessarily yield data which is truly representative of the area under study on a yearly basis for reasons given in (i) – (v) below in this sub-section. However, with some improvements the methodology can be used to yield data which are statistically accurate and meaningful.

The areas in need of improvement are:

(i) No justification is provided for the methodology, in particular the assumption that ~20 kg of waste is generated by each household per week. As the data of interest are weights of garbage generated per household what is important is the number of households used in the sampling procedure, not the total weight of waste sampled (2500 kg recommended in the 1997 EPA methodology). Audits from a number of NSW LGAs conducted over a number of years show that the average waste generated in the majority of cases is closer to 10 kg/household/week than 20 kg/household/week. The sample size recommended (125 households in five samples) may thus be an underestimate in some cases, depending on the waste characteristics of a council. If for instance a council has waste generation statistics which exhibit large standard deviations in individual components then data with greater uncertainties will be obtained using a sample size of 125 households.

(ii) In adopting the sample size using the 2500 kg waste weight, no consideration has been given to the desired (and acceptable) uncertainty and confidence levels in the average values of total waste or those of individual components for accurate determination of waste composition.

(iii) Estimation of waste quantities by volume is not as accurate as weighing components to obtain information on waste characteristics, and should not be used.

(iv) The EPA document notes that four audits per year by LGAs would be 'desirable' whereas this frequency should be compulsory for all LGAs, in order to cover the observed seasonal variations in waste generation. This is particularly important for the accurate determination of the average green waste over the year as it has been shown in a number of audits that more garden waste is generated in spring and summer than in autumn / winter. Once-a-year audits are not sufficient as they represent a 'snapshot' of the period in which the audit was conducted, and thus may not always be valid for extrapolating the information on a yearly basis.

(v) No recommendation has been made for the conduct of audits in a systematic manner over a number of years to generate time-series information to observe changes in waste generation practices. This information may be useful to DECC to determine if the goals for waste management, in particular recovery and waste reduction are being achieved. They may also be used to predict future waste generation."

Attachment 8: Sample Size Calculation

Extract from:
***Singh, N. 2007*. 'Report on the Key Issues with 1997 EPA Methodology Review of the Waste Stream Data Collection Methodologies Document - The Domestic Waste Sub-Stream Methodology'.**

Sample size calculation

The sample size, n, (defined as the number of households in an LGA) that will achieve a specified accuracy (defined with a fixed uncertainty and confidence interval) in the audit data, can be calculated using the following equation:

(Equation 1.)

$$n = \left(\frac{z \times cv}{u} \right)^2$$

where:

- cv is the ratio of the standard deviation to the mean, determined using pre-existing data and expressed as a percentage;
- the z-score (two-tailed) corresponds to any confidence interval (eg. 90%, 95%) and is easily obtained from the internet databases, journal articles or textbooks on statistics;
- u is the percentage uncertainty that will be tolerated in the data.

Example

Sample size, n, plotted as a function of coefficient of variation, cv% at 10% uncertainty and 90% confidence level. The values of n have been calculated using the equation:

$$n = \left(\frac{1.645 \times cv}{10} \right)^2$$

where

- 1.645 is the two-tailed z-score (Z0.05) that corresponds to the desired 90% confidence interval;
- 10 is the desired % uncertainty (u) in the audit data.
- cv is calculated by the ratio of the Standard Deviation to the mean

St Dev[1]	Mean[8]	CV%	Household Sample Size with 10% U, 90% CI
9.8	9.95	98	260

Calculation is 1.645 multiply 98 divided by 10 = 16.121. 16.121 multiply 16.121 = 260

St Dev[1]	Mean [9]	CV%	Household Sample Size with 10% U, 90% CI
8.4	9.95	84	191

Calculation is 1.645 multiply 84 divided by 10 = 13.818. 13.818 multiply 13.818 = 191

Attachment 9: Glossary of Statistical Terms

Extract from
***Singh, N. 2007*. 'Report on the Key Issues with 1997 EPA Methodology Review of the Waste Stream Data Collection Methodologies Document - The Domestic Waste Sub-Stream Methodology'.**

Random Sampling: Random sampling is a sampling technique where a group of subjects (a sample) are selected for a study from a larger group (a population). Each individual is chosen entirely by chance and each member of the population has a known, but possibly non-equal, chance of being included in the sample. By using random sampling, the likelihood of bias is reduced. Random sampling is most appropriate when the entire population from which the sample is taken is homogeneous. It is also a good starting point in the design of a basic statistical survey, the results of which can be used to design the more sophisticated stratified sampling. See Attachment 11 for further information.

Stratified Sampling: There will often be factors which divide the population into sub-populations (groups / strata) and hence the measurement of interest may vary among the different sub-populations. This has to be accounted for when a sample from the population is selected in order to obtain a sample that is representative of the population. This is achieved by stratified sampling. A stratified sample is obtained by taking samples from each stratum or sub-group of a population, e.g., socio-economic differences suburb to suburb. When a population with several strata is sampled, the proportion of each stratum in the sample should be the same as in the population.

Stratified sampling techniques are generally used when the population is heterogeneous, or dissimilar, where certain homogeneous or similar sub-populations can be isolated (strata). Some reasons for using stratified sampling over simple random sampling are:

(i) The cost per observation in the survey may be reduced

(ii) Estimates of the population parameters may be required for each sub-population

(iii) Increased accuracy at given cost.

See Attachment 12 for further information.

Accuracy of Measurement: Closeness of the agreement between the result of a measurement and the true value of the physical parameter being quantified by measurement (a measurand). 'Accuracy' is a qualitative concept and hence it should not be used quantitatively, that is, numbers should not be associated with it; numbers should be associated with measures of uncertainty instead.

Uncertainty of Measurement: A parameter, associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measurand.

Confidence Interval: A confidence interval gives an estimated range of values which is likely to include an unknown population parameter (e.g. mean), the estimated range being calculated from a given set of sample data. If independent samples are taken repeatedly from the same population, and a confidence interval calculated for each sample, then a certain percentage (confidence level) of the intervals will include the unknown population parameter. Confidence intervals are usually calculated so that this percentage is 95%, but percentages such as 90%, 99%, 99.9% of confidence intervals for the unknown parameter are also used. The width of the confidence interval gives an idea about how uncertain we are about the unknown parameter.

Confidence Limits: Confidence limits are the lower and upper boundaries / values of a confidence interval, that is, the values which define the range of a confidence interval.

Confidence Level: The confidence level is the probability value $(1 - \alpha)$ associated with a confidence interval. It is often expressed as a percentage. For example, say $\alpha = 0.05 = 5\%$, then confidence level $= (1 - 0.05) = 0.95$, that is, a 95% confidence level.

Confidence Interval for a Mean: A confidence interval for a mean specifies a range of values within which the unknown population parameter, in this case the mean, will lie.

Arithmetic Mean $\left(\overline{X}\right)$ **:** Arithmetic mean value of a sample of n results is calculated as:

$$\overline{X} = \frac{\sum_{i}^{n} = {}_{1} X_{i}}{n}$$

Sample Standard Deviation $\left(s\right)$ **:** An estimate of the population standard deviation (□) from a sample of n results is calculated using:

$$s = \sqrt{\frac{\sum_{i}^{n} = {}_{1} \left(X_{1} - \overline{X}\right)^{2}}{n-1}}$$

Standard Deviation of the Mean $\left(s_{\overline{x}}\right)$ **:** The standard deviation of the mean $\left(\overline{X}\right)$ of n values taken from a population is given by:

$$s_{\overline{x}} = \frac{s}{\sqrt{n}}$$

Standard deviation is one of the measures to describe the dispersion (or variation) of numerical data about the mean. The terms 'standard error' and 'standard error of the mean' have also been used to describe the same quantity.

Attachment 10: NSW Waste Avoidance and Resource Recovery Strategy 2007 – Key Elements

The *NSW Waste Avoidance and Resource Recovery Strategy 2007* is designed to provide a continuing framework that will guide actions to achieve the Government's policy objectives of minimising environmental harm from waste generation through to disposal, and conserving and maximising resource use.Waste must be tackled across the whole life cycle of goods and materials including extraction, manufacturing, distribution, consumption and recovery for reprocessing or disposal. Action to avoid and prevent waste needs to be considered at every step in this cycle with a focus on those points in the chain where the impact and results will be most effective.

The *NSW Waste Strategy 2007* recognises the importance of the waste hierarchy to guide effective resource management. It acknowledges, however, that different materials require different approaches. The choice of approach, including re-use, recycling and energy from waste, will depend on a balance of factors including economic and environmental considerations. Other factors that will influence the approach adopted for specific materials include: the availability of supply; markets for recyclate; economic, environmental and social impacts; community responses to different collection, reprocessing and disposal options; and emergence of new technologies.

The principles of the *NSW Waste Strategy 2007* include a commitment to ecological sustainable development as well as other principles set out in NSW legislation and international instruments, such as the precautionary principle, inter-generational equity, polluter pays, full life cycle costing, market incentives, shared responsibility, system integration, sustainable production and consumption, public involvement in decision making, economic development and continuous improvement.

The four key result areas for the NSW Waste Strategy 2007 are:

- Preventing and avoiding waste
- Increasing recovery and use of secondary materials
- Reducing toxicity in products and materials
- Reducing litter and illegal dumping.

Broad targets have been identified for each key result area as highlighted in Table 1. These targets have been retained from the 2003 Waste Strategy.

Table 1: Waste Strategy Targets

Preventing and avoiding waste	To hold level the total waste generated for 5 years from the release of Waste Strategy 2003.
Increased recovery and use of secondary resources	By 2014, to: Increase recovery and use of materials from the municipal waste stream, from 26% (in 2000) to 66% Increase recovery and use of materials from the commercial and industrial waste stream, from 28% (in 2000) to 63% Increase recovery and use of materials from the construction and demolition sector, from 65% (in 2000) to 76%
Reducing toxic substances in products and materials	Reduce total amount of litter reported annually Reduction in total tonnages of illegally dumped material reported by regulatory agencies and RID squads annually
Reduce litter and illegal dumping	Reduce total amount of litter reported annually Reduction in total tonnages of illegally dumped material reported by regulatory agencies and RID squads annually

Effective waste management relies on systematically monitoring waste characteristics across all waste streams. These guidelines for household kerbside audits are designed to provide policy makers with reliable information to monitor the targets and to introduce effective waste reduction and minimisation strategies.

The full strategy is available at www.environment.nsw.gov.au

Attachment 11: Simple Random Sampling Estimation

Extract from:
Methodological review of the Kerbside Waste Audit, Statistical Solutions, 2007, Canberra.

Appendix 1: Simple Random Sampling Estimation Details

LGA Level Estimates

If simple random sampling is used within LGAs *number raised estimation* can be employed. This estimation technique works by summing up the sample values and inflating (or *weighting*) this by a factor equal to the reciprocal of the sampling fraction. For example, say 260 households were selected from the population of 150,000. This would result in a sampling fraction of 260/150,000. The sample total waste (either total or of a particular type) would be multiplied by 150,000/260 to give the estimate of total waste.

The following formula is used to estimate total weight of waste for any particular type of waste (w) for LGA (l):

$$\hat{Y}_{w,l} = \frac{N_l}{n_l} \sum_{i=1..n_l} y_{w,l,i}$$

$\hat{Y}_{w,l}$ = estimate of total waste w for LGA l, the $\hat{}$ denotes this is an *estimate* rather than actual total value.

N_l = total number of units in LGA l

n_l = number of units sampled in LGA l

$y_{w,l,i}$ = Weight of waste of type w in the i^{th} unit sampled in LGA l

$\sum_{i=1..n_l} y_{w,l,i}$ = sum of weight of waste of type w from all units sampled in LGA l

The reliability of the estimate (1) can be quantified by a number of related measures: variance, standard error and relative standard error. The *variance* of the estimate is estimated by:

$$\hat{variance}(\hat{Y}_{w,l}) = \frac{N_l^2}{n_l}\left(1 - \frac{n_l}{N_l}\right) s^2_{y_{w,l}}$$

Because we do not know the true variability of waste, this formula is an estimate of the true variance of the estimate and is denoted with a $\hat{}$.

$s_{y_{w,l}}$ is the sample standard deviation and is given by the following formula:

$$s_{y_{w,l}} = \sqrt{\frac{1}{n_l - 1} \sum_{i=1..n_l} \left(y_{w,l,i} - \bar{y}_{w,l}\right)}$$

this formula uses $\bar{y}_{w,l}$ which is the value of the mean waste w in LGA l, calculated simply by summing the sample values in each LGA and dividing by the sample size:

$$\bar{y}_{w,l} = \frac{\sum_{i=1..n_l} y_{w,l,i}}{n_l}$$

The *standard error* of the estimate is simply the square root of the variance of the estimate:

$$\hat{std\ error}\left(\hat{Y}_{w,l}\right)=\sqrt{\hat{variance}\left(\hat{Y}_{w,l}\right)}$$

this can be combined with (2) to give:

$$\hat{std\ error}\left(\hat{Y}_{w,l}\right)=\sqrt{\frac{N_l^2}{n_l}\left(1-\frac{n_l}{N_l}\right)s^2_{y_{w,l}}}$$

The *relative standard error* (or RSE) of the estimate is the ratio of the standard error to the estimate. The formula for the RSE is given by:

$$\hat{RSE}\left(\hat{Y}_{w,l}\right)=\frac{\hat{std\ error}\left(\hat{Y}_{w,l}\right)}{\hat{Y}_{w,l}}$$

The RSE is often expressed as a percentage.

Attachment 12: Estimation for Stratified Sampling

Stratified sampling: In stratified sampling, the population is divided into groups called strata. A sample is then drawn from within these strata. Stratification is most useful when the stratifying variables are simple to work with, easy to observe and closely related to the topic of the survey.

An important aspect of stratification is that it can be used to select more of one group than another.

Source: Australian Bureau of Statistics. 'Stratified sampling'. http://www.abs.gov.au/websitedbs/D3310116.NSF/a91a469056624a32ca256eb000026ca7/116e0f93f17283eb4a2567ac00213517!OpenDocument

Extract from Statistical Solutions 2007. Methodological review of the Kerbside Waste Audit, Statistical Solutions, Canberra.

Appendix 6 Estimation for Stratified Sampling

Where stratification has been used the estimates should first be calculated using one of the above methods to create stratum level estimates. For example, say an LGA (l) is divided into H_l strata, with a sample of $n_{l,h}$ units selected SRSWOR within each strata (the number per strata can vary, e.g. a proportional sample would be reasonably). Stratum level estimates and variances are first calculated:

$$\hat{Y}_{w,l,h}=\frac{N_{l,h}}{n_{l,h}}\sum_{i=1..n_{l,h}} y_{w,l,h,i}$$

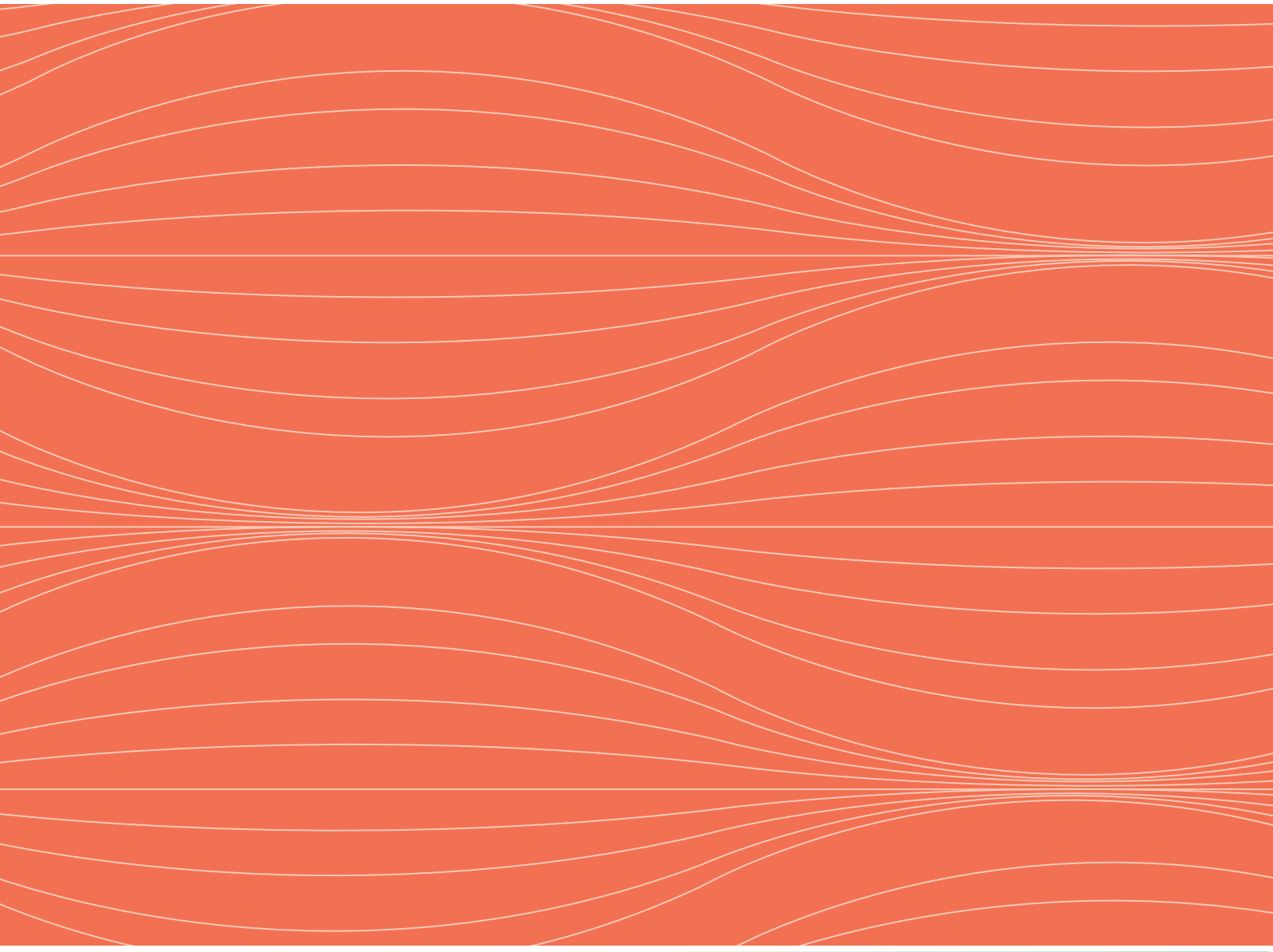
$$\hat{variance}\left(\hat{Y}_{w,l,h}\right)=\frac{N_{l,h}^2}{n_{l,h}}\left(1-\frac{n_{l,h}}{N_{l,h}}\right)s^2_{y_{w,l,h}}$$

The LGA level total would then be calculated using:

$$\hat{Y}_{w,l}=\sum_{h=1..H_l}\hat{Y}_{w,l,h}$$

The estimate of variance of this LGA estimate is the sum of the stratum level estimates of variance:

$$\hat{variance}\left(\hat{Y}_{w,l}\right)=\sum_{l=1..H}\hat{variance}\left(\hat{Y}_{w,l,h}\right)$$



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