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FOOD**
hate waste
CANADA

**J'AIME
MANGER**
pas gaspiller
CANADA

How to Measure Food Waste:

A Guide for Measuring Food Waste
from Households in Canada

JUNE 2018

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NATIONAL ZERO WASTE COUNCIL

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J'AIME
MANGER
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How to Measure Food Waste: Executive Summary

“If you can’t measure it, you can’t improve it.”

– Peter Drucker, business author

Introduction

Reducing food waste in Canada offers economic and environmental benefits. But tackling this issue demands a good understanding of the sources and causes of food waste, the ways in which it can be quantified, and the background knowledge to apply the best approach for your particular circumstances.

This document provides a basic overview of all three aspects, so you can implement a food waste study that delivers good data – pointing the way to intelligent choices for action.

Why Measure Food Waste?

Measuring food waste gives a better understanding of the volume and nature of the food being thrown away. With that baseline data in hand, municipalities and other orders of government can measure their efforts to reduce waste, determine which methods deliver the most success, and improve their waste prevention strategies. Further, as consistent methodologies are adopted across the country, the aggregated data provides a valuable national perspective. With a better understanding of food waste issues across Canada, it becomes easier to work toward national-level approaches and solutions.

Food Waste Terminology and Definitions

Tackling a problem like food waste systematically requires establishing consistent terminology for what is being measured. The following definitions are adapted from the internationally recognized *Food Loss and Waste Accounting and Reporting Standard*.¹

- **Food:** Substances (including drinks) intended for human consumption. Also includes spoiled material no longer fit for consumption and substances used in the making of the food. Does not include water or other processing agents.
- **Inedible Parts:** Material associated with a food, but is not generally consumed in some markets. Examples include pits, rinds, and bones. Does not include packaging.
- **Food Loss:** Food and associated inedible parts removed from the food supply chain to be recovered, recycled or disposed. Food loss generally applies to the production and distribution stages of the supply chain.
- **Food Waste:** Food that is not consumed at the retail, food service and consumer stages of the food supply chain.

Food Waste Quantification Methodologies

It's not the most glamorous task, but sometimes addressing food waste means literally digging deeper into the waste stream to understand what and how much is being thrown away. To figure out what's in our food waste, kitchen diaries and waste composition studies are the two most common forms of data collection. Waste composition studies can be conducted through an aggregated sampling method (bulk or small area-based) or individual sampling. Recruitment of participants in a

kitchen diary study can use a stratified random selection or open recruitment method. The different forms of data collection and the associated sampling methodology are described more fully in this document.

Which Study Method is Right for You?

All of the study methods listed above have positives and negatives to consider. For many decision-makers, cost is likely top-of-mind. Nonetheless, if a particular approach cannot deliver the information necessary to make good waste prevention decisions, even a low-cost study may be money wasted.

Determining the right approach for your food waste study also means determining what it is you are trying to find out. With a clear sense of your end goal in mind, you can decide whether you need the detailed and specific information of a kitchen diary, or if the general information provided by a bulk sample study is sufficient data.

This document contains detailed information, a decision tree, and comparison charts to help you choose what would best align with your needs.

Conclusion

The massive amount of food waste in Canada impacts our nation's environment, health, and financial resources. Successful approaches to reduce wasted food will require a greater understanding of the factors at play. That's why measuring food waste must become a priority for Canadian policy-makers. With good data in hand, collected using similar methodologies across the country, we can gain a better understanding of the strengths and weaknesses inherent in current food management and waste systems, the motivating factors behind household choices surrounding food waste, and the solutions offering the best return on our investments.

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1. Canada's National Zero Waste Council and Love Food Hate Waste Canada Campaign

The National Zero Waste Council was founded by Metro Vancouver in collaboration with Federation of Canadian Municipalities (FCM) as a leadership initiative bringing together governments, businesses and non-governmental organizations to advance a waste prevention agenda in Canada. Making progress in preventing waste by local governments taking action alone is not possible. Through a collaborative approach that involves important stakeholders, the Council promotes better alignment with global initiatives in design change, policy innovation, and behaviour change that will be successful in preventing waste in global markets.

The Council has identified reducing food waste in Canada as a strategic priority and the opportunity for making progress is enhanced by concern that government, media and the public has expressed about the size of the problem. The economic impact of food waste in Canada is conservatively estimated

at \$31 billion annually but if the cost of resources and energy wasted throughout the food value chain in producing, processing and distributing food that is eventually wasted is included, the cost spirals to more than \$100 billion per year.² Reducing food waste in Canada therefore would result in cost savings for most stakeholders but will also create new economic opportunities for businesses looking to expand their markets and product types. There would also be community benefits associated with better use and distribution of surplus foods while reducing the amount of food waste going to landfills could make a contribution to Canada's commitment to reduce its greenhouse gas emissions.

Since waste occurs along all elements of the supply chain – from food production through to retail and post-consumer disposal as garbage – solving food waste requires a collaborative effort. Important initiatives are already underway in Canada to reduce food waste, including some initiatives involving strategic collaborations. However, most actions are implemented



in a fragmented fashion and lack coordination and collaboration. What is lacking is a systems-based analysis to support a vision for change and inform strategy and tactic development and implementation.

In response, the National Zero Waste Council has developed *A Food Loss and Waste Strategy for Canada*.³ The Strategy was informed by actions already underway by businesses, community organizations and governments in Canada, as well as from the US and Europe. It is hoped that this Strategy offers a rallying point for numerous and diverse stakeholders; that it provides tangible solutions that leverage action emerging in Canada and other parts of the world; and that it offers a clear way forward.

Love Food Hate Waste Canada

An essential component of reducing food waste in Canada is engaging Canadians to make better decisions about how to shop, store and prepare food. Some very simple but mindful changes can lead to substantial reductions in food waste generated by households. Love Food Hate Waste is a public education campaign developed by the Waste and Resources Action Programme (WRAP) in the U.K. to reduce food waste. It is now a globally recognized and proven campaign active around the world. Canada's National Zero Waste Council initiated the Love Food Hate Waste Canada campaign as a key deliverable of its Strategy to reduce food waste across Canada.

Love Food Hate Waste Canada is a multi-year, collaborative campaign bringing together governments, retailers and others to help consumers rethink their relationship with food. The campaign, launched in 2018, by the National Zero Waste Council in collaboration with its campaign partners will provide consumers across Canada tips and ideas to effectively prevent food waste.

Love Food Hate Waste Canada engages Canadians to think about how households generate food waste and how by making different decisions when buying and storing food and in preparing meals, they can reduce this waste of resources. The advantage of a national campaign is the common messaging coming from a variety of partners from local and provincial governments to food retailers and other stakeholders using multiple platforms (e.g., via social media, in-store promotions, bus shelters).

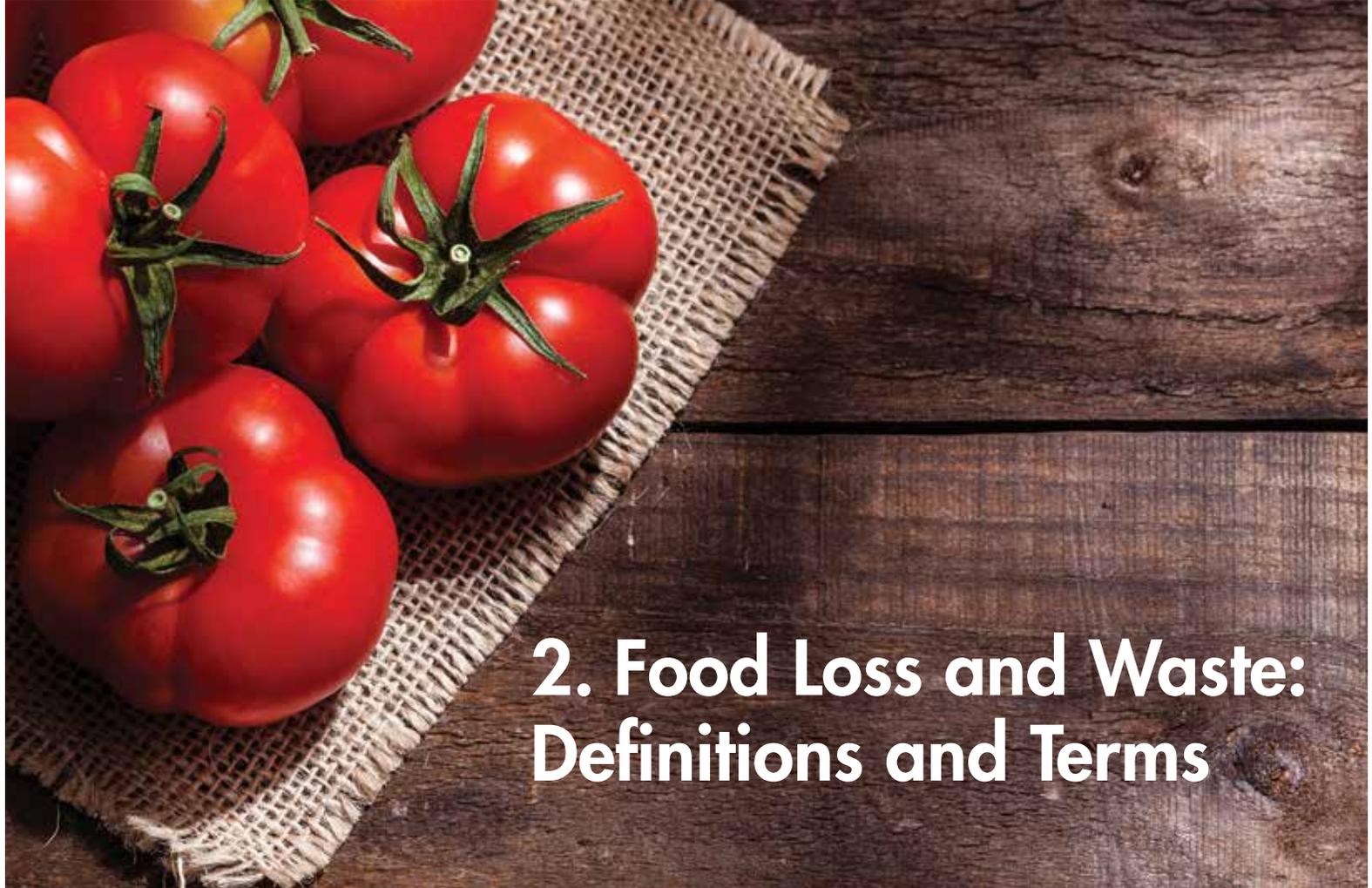
The objective of Love Food Hate Waste Canada is to prevent household food waste from occurring in the first place. The benefits of becoming a campaign partner are specific:

- For local governments, preventing wasted food reduces the amount of organics that needs to be managed. The campaign also provides local governments opportunities to inform and engage residents on a topical issue.
- For grocers, the campaign provides a way to engage directly with consumers on an issue of mutual concern and in a manner consistent with increasing brand recognition and customer loyalty.

Working across Canada using common, effective messaging should result in less food waste and therefore a food system with a smaller carbon footprint that uses less natural resources. At the same time, families and individuals may reduce their food costs.

² Value Chain Management International, 2014. "The Cost of Canada's Annual Food Waste". Available at: vcm-international.com/wp-content/uploads/2014/12/Food-Waste-in-Canada-27-Billion-Revisited-Dec-10-2014.pdf

³ <http://www.nzwc.ca/focus/food/national-food-waste-strategy/Documents/NZWC-FoodLossWasteStrategy.pdf>



2. Food Loss and Waste: Definitions and Terms

Tackling a problem like food waste requires establishing standards for quantifying it. This is important for tracking food waste over time as well as in comparing or amalgamating data across jurisdictions. The Food Loss and Waste Accounting and Reporting Standard (FLW Standard) was established as a voluntary global standard for quantifying and reporting food loss and waste (FLW). By aligning with this standard, definitions and terminology are consistent, which allows for better comparability between different studies.

The FLW Standard provides a modular framework that enables entities to use a common set of terms to define what they include when referring to FLW or any similar term. The FLW Standard defines the possible material types, as well as the possible destinations of the material that is removed from the food supply chain.

The distinction between food and inedible parts was adapted from the FLW Standard as follows:⁴

Food: Any substance – whether processed, semi-processed, or raw – that is intended for human consumption. Food includes drink, and any substance that has been used in the manufacture, preparation, or treatment of food. Food also includes material that has spoiled and is therefore no longer fit for human consumption. It does not include cosmetics, tobacco, or substances used only as drugs. It does not include processing agents used along the food supply chain, for example, water to clean or cook raw materials in factories or at home.

Inedible Parts: Components associated with a food that, in some markets, are not intended to be consumed by humans. Examples of inedible parts associated with food could include bones, rinds, and pits/stones. Inedible parts do not include packaging. The distinction between food and inedible parts varies among users (e.g., there is a market for chicken feet but not as large of a market for other chicken parts), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price,

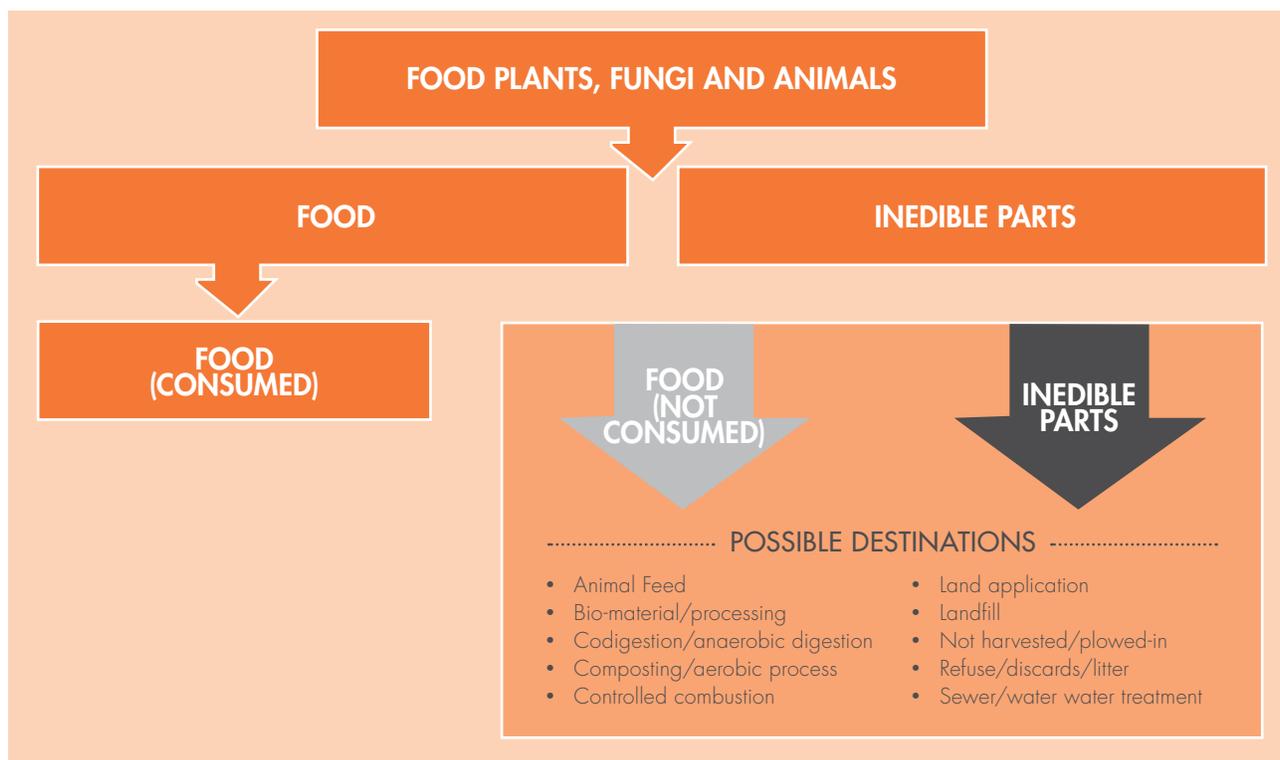


Figure 1: Possible Destinations of Food Loss and Waste (FLW Protocol Steering Committee 2016)

technological advances, international trade, and geography.

Possible destinations for FLW defined by the FLW Standard are presented on *Figure 1*. Food is only considered to have been lost or wasted if it is not consumed by humans. In other words, rescued food is not FLW as long as it is ultimately consumed by humans. However, if food is rescued but not consumed (e.g. spoiled donations), then it is FLW.

Food loss: Food and associated inedible parts removed from the food supply chain to be recovered, recycled or disposed (i.e., all ten destinations included in the FLW Standard). Food loss encompasses food waste and spans all stages of the food supply chain (from production to consumption) but generally refers to loss experienced from production through distribution.

Food waste: Food that is not consumed at the retail, food service and consumer stages of the food supply chain.

In this report, definitions of FLW have been taken from the Commission for Environmental Cooperation's (CEC) Characterization and Management of Food Loss and Waste in North America report.⁵ Since the Love Food Hate Waste Canada benchmarking methodology only applies to households, food waste is the most appropriate term.

⁴ FLW Protocol Steering Committee. 2016a. Food Loss and Waste Accounting and Reporting Standard. http://flwprotocol.org/wp-content/uploads/2017/05/FLW_Standard_final_2016.pdf

⁵ <http://www3.cec.org/islandora/en/item/11774-characterization-and-management-food-waste-in-north-america-foundational-report-en.pdf>



3.

3. Why Measure Food Waste?

United Nations General Assembly adopted a set of 17 Sustainable Development Goals (SDGs) in 2015. SDG 12 seeks to “ensure sustainable consumption and production patterns” and the third target (Target 12.3) calls for halving per capita global food waste at the retail and consumer levels and reducing food losses along production and supply chains (including post-harvest losses) by 2030.⁶

On a global scale, progress on this target is important. Each year, an estimated one third of all food produced – equivalent to 1.3 billion tonnes worth around \$1 trillion – ends up rotting in the bins of consumers and retailers, or spoiling due to poor transportation and harvesting practices. Food waste represents a waste of resources and contributes to climate change. Reducing food waste creates new economic opportunities, redirects healthy and safe foods to worthwhile community initiatives, and contributes to more sustainable environmental conditions.

In Canada, as in other middle and high-income regions, the majority of food waste occurs in the post-harvest stages of the food chain – in processing, wholesaling, retailing and final consumption. This is important because as the Food and Agricultural Organization (FAO) indicates, when food is wasted further down the food supply chain, the environmental consequences per tonne of food wasted grows. Food waste occurring at the end of the supply chain includes the embedded resources, energy, and labour involved in processing, packaging, transport, storage, and preparing of food.

Champions 12.3 is a coalition of executives from governments, businesses, international organizations, research institutions, farmer groups, and civil society dedicated to inspiring ambition, mobilizing action, and accelerating progress toward achieving SDG Target 12.3 by 2030. Champions 12.3 articulates a three-step approach for reducing food loss and waste: target, measure, and act.⁸ While what ultimately matters is

taking action, for local governments setting targets are important. Targets provide a focus and motivates action. A basic tenet in business is “what gets measured gets managed” so by quantifying food loss and waste, decision-makers can better understand the problem in their communities and can evaluate the impact of changing policies and other actions.

As most policies and targets for solid waste are set by provincial and local governments, measurement of FLW increases accountability toward meeting FLW reduction commitments or requirements. FLW data can also provide inputs to environmental indicators for other targets such as avoiding greenhouse gas emissions from food waste in landfills. Other benefits of FLW measurement for provincial and local governments include:

- Improving projections of capacity needs for organics processing and disposal facilities as food waste is one of the largest components of municipal solid waste (by weight);
- Understanding major causes and sources of FLW to tailor policies and program design to optimize the level of impact; and
- Identifying sources of surplus food or edible byproducts that could be rescued for secondary markets or donation.



⁶ <https://sustainabledevelopment.un.org/sdg12>

⁷ <http://www.fao.org/save-food/resources/keyfindings/en/>

⁸ <https://champions123.org/2017-progress-report/>



4. How to Plan and Implement a Food Waste Measurement Study

The most common methodologies used by leading organizations working on quantifying food waste from single and multi-unit residential households are waste composition studies and kitchen diaries. General descriptions of these methodologies are presented in this section. More detailed descriptions of both methodologies can be found in the FLW Standard’s Guidance on Quantification Methods for Waste Composition Analysis⁹ and Diaries.¹⁰

Waste Composition Studies

A waste composition study involves physically separating, weighing, and categorizing food waste. Compared to visual audits, which generally uses volumetric estimates or item counts, this method is also considered to be more accurate since measurement by volume requires conversion to weight through assumed densities or material sizes. By collecting weight data directly, it eliminates the additional error associated with conversions.

Waste composition studies are best suited for collecting detailed information about food waste and overcome under-reporting issues or participant biases associated with surveys and kitchen diaries. However, they only account for food waste destinations associated with municipal solid waste (e.g., compost/aerobic processes, anaerobic digestion, controlled combustion, landfill). Food waste fed to animals, disposed down the drain, or in backyard compost are not captured. Another challenge with this method is separating materials in compacted loads (more applicable when collected in compactor trucks), since food waste may become indistinguishable or water weights are lost (e.g., leaked out or transferred onto drier items such as paper).

The categories used for waste composition studies can range from basic categories (e.g., food, inedible parts) to primary food categories (e.g., meat, vegetables) and detailed categories (e.g., apples, bananas).

⁹ http://flwprotocol.org/wp-content/uploads/2016/06/FLW_Guidance_Chapter4_Waste_Composition_Analysis.pdf

¹⁰ http://flwprotocol.org/wp-content/uploads/2016/06/FLW_Guidance_Chapter6_Diaries.pdf

Waste composition studies can be conducted through an aggregated (bulk or small area-based) or individual sampling method, as described below.

Waste composition data can be extrapolated based on tonnages from solid waste management facilities or population data.

More detailed information about food waste collection studies can be accessed in a separate document of technical appendices.

Bulk Sampling

Bulk sampling typically occurs at a transfer station or disposal/processing location (e.g., landfill, compost facility) where collection vehicles unload materials. Each load represents one collection route, which represents approximately 500 to 1,000 households, depending on the size of the truck, compaction, and waste disposal habits in the area. Single family households normally have designated vehicles for collection and therefore loads are not mixed with other sectors. Multi-unit households may be collected with samples from the industrial, commercial, and institutional (ICI) sector, and therefore is more challenging to segregate. In some cases, arrangements are made with the hauler to only collect from multi-unit households (described further under small area-based sampling). Waste generators are not aware that their waste is being sampled using this method.

Samples are selected from loads by selecting a section of the load for sorting using a random number generator system. Sample sizes typically range from 90 kg to 135 kg.¹¹

Small Area-Based Sampling

Small area-based sampling involves collecting waste from a specific physical area. The waste is collected in aggregate, similar to bulk sampling, but the generators are targeted. For example, the designated area may be a particular street or neighbourhood, or a select number

of multi-unit residential buildings. Normally, the waste generators are not made aware that their waste is being sampled using this method. In some cases, households are informed of the waste composition study taking place, or are provided information upon inquiry, and have the option to opt-out of having their waste collected.

Depending on the size of the load collected, either all the materials are sorted or 100 kg is sampled from a randomly selected section of the load.

Individual Sampling

Waste samples are collected from individual households. These households can be recruited through stratified random selection or open recruitment. For single family homes or multi-unit homes with individual collection containers, samples are collected from curbside set outs. For multi-unit residential buildings with shared containers, additional coordination is required to have residents place garbage (or other material streams) in separate bags, tagged with a unique identifier that refers to their household. Sampling is conducted anonymously (i.e., homes are only identified by a sample code, not by their address).

When sampling from curbside set outs, households do not necessarily need to know that their waste is being collected; however, it is common practice to provide notification so that there is an option to opt-out. In some cases, informed consent is required, particularly when the waste composition study is linked with a survey or kitchen diary. For multi-unit residential buildings, informed consent is necessary since residents need to take the extra step of placing their waste in tagged or labelled bags.

¹¹ Recommended Waste Characterization Methodology for Direct Waste Analysis Studies in Canada. (1999) CCME http://www.ccme.ca/files/Resources/waste/packaging/pn_1497_waste_char.rpt_final_e.pdf

Food Diaries

Kitchen diaries involve having individuals or group of individuals (e.g. all members of a household) maintain a daily log of food waste and other information. Participants are recruited to complete a self-reported kitchen diary, normally for a one week duration. Participants record the weight, volume, or item counts of their food waste before it is disposed along with information such as the time, disposal destination, state of the food, and reason for disposal. Participants may also complete a survey before and/or after the diary to provide data on demographics and household food practices.

Kitchen diaries are a useful tool to identify behaviours linked to food waste and quantify food waste that is not collected through municipal waste collection systems. However, the self-reporting nature of the diary may lead to some data inaccuracies. Sources of inaccuracy include under-reporting through intentional or unintentional omissions of occurrences of food waste, changes in behaviour that result from the act of completing a diary (e.g., participants want to show they don't waste food and alter their food consumption patterns for that week), and recruitment bias (e.g., only participants that are interested in food waste issues sign up or less-interested participants drop out).

While the data collected may be offset from true values, this type of error would be systemic between repeated studies and therefore any difference between the two studies represents a valid difference. Furthermore, a variety of methods can be employed to improve data accuracy. Methods to adjust for under-reporting in kitchen diaries include conducting a waste composition study on participating households or comparing kitchen diary data to waste composition studies conducted in the same or similar jurisdictions. Methods to reduce recruitment bias include offering honouraria or other incentives to participate in order to attract participants that are not as interested in food waste issues or using stratified random selection versus open recruitment.

Kitchen diary data can be extrapolated using population and household composition data.

Stratified Random Selection

The target population (e.g., all residents of a municipality) are divided into key groups (strata) based on factors such as housing type, neighbourhood, income level, age, or other demographic variables. Targets or quotas for each of these strata are set such that the kitchen diary participants represent the population as a whole. Participants are then randomly recruited within each strata through in-person (e.g., door-to-door) recruitment, panels, or telephone calls. Only households targeted for recruitment are able to sign up for the study.

Open Recruitment

An open call for participation in a kitchen diary is advertised to the entire target population in a variety of communication methods such as traditional media, social media, email lists, or word-of-mouth. Anyone who responds can sign up, regardless of their demographic group.

Factors in Selecting Appropriate Study Type

For the purposes of comparison, the quantification methodologies described in this section are divided into three study types: waste composition study (bulk or small area-based sampling), waste composition study (individual sampling), and kitchen diaries.

The reason for subdividing waste composition studies between bulk and individual sampling is that the methodological differences in sample selection are large enough to affect multiple decision-making factors. The study types are defined as follows:

- Waste composition study (bulk or small area-based sampling): Waste samples are collected on a regular

or targeted collection route from multiple households in a collection vehicle. Loads are randomly subsampled, manually sorted into different food waste categories and weighed to determine composition.

- Waste composition study (individual sampling): Waste samples are collected from individual households, then manually sorted into different food waste categories and weighed to determine composition.
- Kitchen diaries: Participants are recruited to complete a self-reported kitchen diary whereby all food waste is logged over a designated time frame.

A comparison table of the three study types with consideration for decision-making factors that may be faced by an entity undertaking food waste quantification is presented in *Table 1*.

Definitions of decision-making factors are as follows:

- Cost/resources required: Financial, material, and human resources to undertake the study.
- Understanding of drivers of food wastage: Obtaining insights on attitudes and behaviours related to food waste from a study.
- Differentiation of food categories in waste: Ability to distinguish different types of food waste.
- Understanding of demographics: Obtaining demographic information on the generators of food waste.
- Level of data objectivity: Certainty that data represents typical food wasting behaviours.
- Food waste destinations captured: Number of possible destinations of food waste included in the scope of the study.



TABLE 1: COMPARISON OF FOOD WASTE QUANTIFICATION STUDIES BASED ON KEY DECISION-MAKING FACTORS

DECISION-MAKING FACTOR	STUDY TYPE		
	WASTE COMPOSITION STUDY (AGGREGATED SAMPLING)	WASTE COMPOSITION STUDY (INDIVIDUAL SAMPLING)	KITCHEN DIARIES
COST/RESOURCES REQUIRED	<p>LOW</p> <ul style="list-style-type: none"> Lowest cost on a per-sample basis as the main resource requirement is for sorting and data analysis If waste composition studies are already conducted on a regular basis, they can be adapted to include food waste categories with minimal cost implications 	<p>MEDIUM</p> <ul style="list-style-type: none"> Samples need to be collected by a designated team and cannot be conducted using a collection vehicle on a regular route If informed consent is required, additional resources are needed for participant recruitment Requires a larger number of samples for statistical significance due to smaller sample weights which increases resource needs for collection, sorting, data entry and analysis 	<p>HIGH</p> <ul style="list-style-type: none"> Participant recruitment requires a large amount of resources to ensure representation Each participant requires several points of contact and ongoing support An incentive (\$50 to \$150) is typically offered to each participant for study completion, as well as a kitchen scale Requires the most amount of time for data entry, compilation, and analysis
UNDERSTANDING OF DRIVERS OF FOOD WASTAGE	<p>LOW</p> <ul style="list-style-type: none"> Participants do not know that they are participating in a study and thus cannot be asked to complete a survey A general survey can be conducted, but is not linked to waste sample generators 	<p>MEDIUM</p> <ul style="list-style-type: none"> A survey may be conducted to obtain data on attitudes and behaviours related to food waste 	<p>HIGH</p> <ul style="list-style-type: none"> Participants can be asked why they wasted food each time data is recorded A pre- and/or post-survey is typically conducted to obtain data on attitudes and behaviours related to food waste; however, lengthy surveys may result in lower completion rates
DIFFERENTIATION OF FOOD CATEGORIES IN WASTE	<p>MEDIUM</p> <ul style="list-style-type: none"> Items may be harder to separate from other materials due to compaction in trucks but are generally still distinguishable 	<p>HIGH</p> <ul style="list-style-type: none"> Samples are typically collected directly from household containers or bags and not compacted, therefore items are more intact and easier to separate 	<p>HIGH</p> <ul style="list-style-type: none"> Food waste is recorded as detailed descriptions by item

TABLE 1: COMPARISON OF FOOD WASTE QUANTIFICATION STUDIES BASED ON KEY DECISION-MAKING FACTORS (CONT.)

DECISION-MAKING FACTOR	STUDY TYPE		
	WASTE COMPOSITION STUDY (AGGREGATED SAMPLING)	WASTE COMPOSITION STUDY (INDIVIDUAL SAMPLING)	KITCHEN DIARIES
UNDERSTANDING OF DEMOGRAPHICS	<p>LOW</p> <ul style="list-style-type: none"> Only broad geographies of study participants can be known, so demographics are limited to general information (e.g., census data) More coordination or cost may be needed to isolate multi-unit sector samples More challenging to determine per household or per capita food waste generation 	<p>MEDIUM</p> <ul style="list-style-type: none"> A survey may be conducted to acquire demographic information specific to the generators 	<p>HIGH</p> <ul style="list-style-type: none"> Participants typically complete a survey that includes demographic information
LEVEL OF DATA OBJECTIVITY	<p>HIGH</p> <ul style="list-style-type: none"> Study participants are not aware of their participation 	<p>MEDIUM</p> <ul style="list-style-type: none"> Study participants are typically aware of their participation, but not asked to do anything outside of their usual routines 	<p>LOW</p> <ul style="list-style-type: none"> Participants may change their behavior as they monitor it or complete the diary based on what they consider socially desirable Due to self-reported nature of kitchen diaries, participants may not record all food wasted With additional resources, kitchen diaries may be conducted in concert with waste composition studies to ground-truth data
FOOD WASTE DESTINATIONS CAPTURED	<p>MEDIUM</p> <ul style="list-style-type: none"> Only includes destinations for municipal solid waste, but the majority of food waste is disposed in that stream Cannot capture food waste that is fed to animals, disposed down the drain, or backyard-composted 	<p>MEDIUM</p> <ul style="list-style-type: none"> Only includes destinations for municipal solid waste, but the majority of food waste is disposed in that stream Cannot capture food waste that is fed to animals, disposed down the drain, or backyard-composted 	<p>HIGH</p> <ul style="list-style-type: none"> Participants are typically instructed to record all food wasted, including amounts fed to animals, disposed down the drain, or backyard-composted Allows for quantification of beverage waste, as the majority is disposed down the drain



5. Proposed Methodology

Selecting the Type of Study: Decision Tree

The primary factor faced by the majority of entities working on food waste quantification is the amount of resources available. Often, resource limitations dictate what type of study is feasible. The decision tree presented in *Figure 2* can help with study selection. The decision tree is meant to provide a general guideline for selecting the type of study. Ultimately when collecting data to establish a baseline and track progress, it is important for the methodology to stay consistent between measurement events. Another tool that can be used to assist with selecting the type of study is the FLW Quantification Method Ranking Tool.¹²

Sample Selection

Availability of resources normally dictates the number of samples for a study. Where resources are available, the minimum number of samples to obtain statistically valid results can be calculated using a power calculation:

$$n = \left(\frac{Z\sigma}{E} \right)^2$$

Where n is the size of the sample, Z is the standard score of a normal distribution of the selected confidence interval, σ is the estimated standard deviation of the outcome variable (amount of food waste) for the population, and E is the desired margin of error.

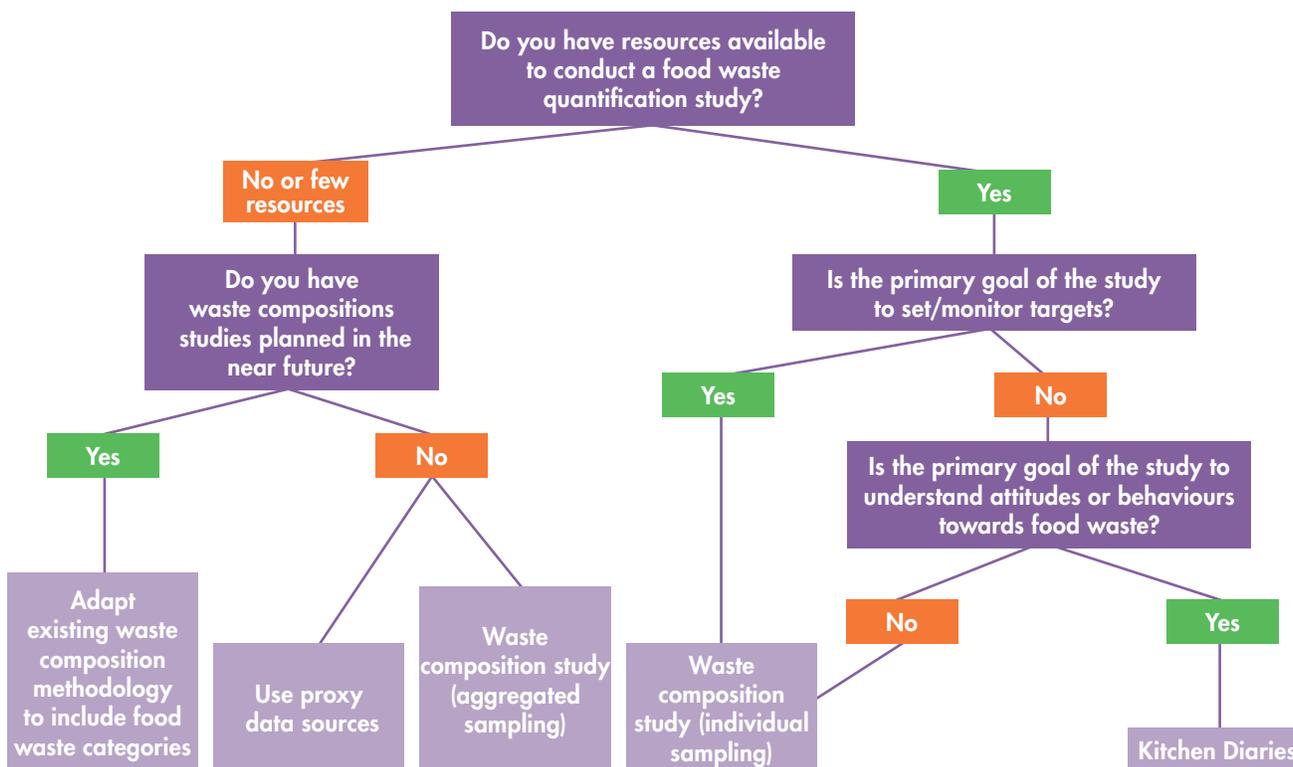


Figure 2: Decision Tree for Selection of Study Type

The standard deviation can be taken from a previous study with a comparable method and population (e.g., residential food waste measurement in another Canadian city). The desired margin of error can be calculated by applying a percentage to the estimated mean. Below is an example calculation assuming a 95% confidence level ($\alpha = 0.05$) and 10% margin of error using an estimated mean of 150 kg/household/year and standard deviation of 130 kg/household/year:

$$n = \left(\frac{Z\sigma}{E}\right)^2 = \left(\frac{1.96 * 130}{150 * 0.10}\right)^2 = 288$$

Waste Composition Studies

Samples can be selected for waste composition studies in one of three ways: bulk sampling, small area sampling, and individual sampling. Individual sampling is recommended over bulk or small area sampling to reduce compaction of materials and allows for collection of data on a per-household basis. However, bulk and small area sampling can be used as lower-cost options. Regardless of the sampling strategy, both the garbage and organics (if food waste is collected) should be sampled to capture both food waste destined for disposal and diversion. The quantity of food waste in recycling is typically nominal compared to garbage and organics.

The following subsections describe general procedures for sampling. Background information on sampling methodologies can be found in the Recommended Waste Characterization Methodology for Direct Waste Analysis Studies in Canada report¹³ (CCME 1999).

¹³ CCME. 1999. Recommended Waste Characterization Methodology for Direct Waste Analysis Studies in Canada. http://www.ccme.ca/files/Resources/waste/packaging/pn_1497_waste_char.rpt_final_e.pdf

A combination of sampling strategies may be used in one waste composition study. For example, bulk sampling may be used for single family homes and small area sampling may be used to segregate garbage from multi-unit homes.

Bulk Sampling

At a transfer station or disposal/processing location, coordinate with operations staff on procedures to identify collection vehicles containing garbage and other materials from the target population and set aside a location for the load to be emptied where the full load can be seen.

After the collection vehicle has emptied the load, divide the load evenly into segments (e.g., a 3x3 grid) and number each segment. Randomly choose one segment (e.g., using a random number generator) to sample from. Collect approximately 100 kg (+/- 10 kg) of material from the selected segment for sorting. Large bulky objects should not be collected as part of the sample.

Small Area Sampling

When a collection vehicle reaches a transfer or disposal/processing location, the procedure for sampling a load for small area sampling is the same as bulk sampling. The only difference is in the planning process for how the load is obtained. Coordinate with municipal operations staff or private haulers to designate specific vehicles to collect materials for the waste composition study from representative routes. Collection should take place on the same day as the regular collection schedule so residents do not need to be notified of the study and follow their regular habits. Representation may be based on geography, demographics (e.g., income level or housing type), or a combination of the two variables. Geographical representation is the easiest to coordinate, as it typically can be organized based on existing collection routes. For example, one route from each of the northern, southern, eastern, and western parts of a city can be selected and the license plates of the targeted vehicles can be relayed to waste sorting team.

Individual Sampling

It is assumed that informed consent is not required for individual sampling. However, it is highly recommended that copies of a letter from the participating jurisdiction describing the study be carried by staff while collecting samples. That way, information can be provided if requested by residents. If informed consent is required, then households need to be recruited first using stratified random selection.

The selection of households for sampling is similar to the approach used for small area sampling, which is to ensure representation of the population in the collected samples. Samples are collected by a designated team instead of a regular collection vehicle, so there can be more flexibility in route selection. A cargo van or cube truck is used for sample collection, depending on the target number of samples and anticipated volume per sample based on residents' disposal habits.

For homes with curbside collection services, sample collection takes place on the regular collection day at a time after most residents have set out materials for collection, and before collection vehicles arrive in the area. Where possible, coordinate with the hauler on route timing to ensure collection vehicles do not start their routes in the target area before samples have been collected. When collecting samples from curbside setouts, collect all materials set out in garbage and organics (if applicable) except for large bulky objects and segregated yard and garden debris (e.g., leaf bags, branch bundles). Samples from each household should be bagged and labelled to keep materials from individual households separate.

Individual sampling for multi-unit homes is not recommended because it is very cumbersome and therefore difficult to coordinate. A recommended alternative to individual sampling for multi-unit residential buildings is to collect all the garbage generated by the building on the regularly scheduled collection day(s) over a one week period and divide the weight of the materials by the number of units. This method requires less coordination, reduces the risk of participation and

social desirability bias, and still allows for a per household generation rate to be calculated. When sampling is conducted in this way, all materials should be weighed. If the sample is greater than 100 kg, then randomly subsample 100 kg for sorting.

Kitchen Diaries

To ensure representation of data collected, it is recommended to recruit participants for kitchen diaries using stratified random selection. Do not use open recruitment as it can increase bias in the dataset. Similar to small area-based and individual sampling, the strata used for stratified random selection can be determined based on a combination of geographic and demographic representation.

Participants can be recruited via one of three methods:

- **In-Person:** Recruitment staff go door-to-door in selected neighbourhoods or lobbies of multi-unit residential buildings to recruit participants.
- **Phone:** Phone numbers are randomly selected within geographic areas (e.g., postal codes) and called to recruit participants.
- **Panels:** Members of existing survey panels are contacted. Panelists that fit within the target geographic or demographic parameters are randomly selected to participate.

To encourage more representative participation, an incentive should be offered (e.g., a \$100 gift card). Otherwise, participation will likely be biased towards civic-minded people who are interested in food waste or environmental issues.

Food Waste Categories

The minimum level of food waste categorization is differentiating food from inedible parts. There is a substantial level of subjectivity involved in determining

which components of food products are considered to be inedible parts. This can be managed through setting clear protocols and how corresponding training is implemented.

For some items (e.g., egg with shell, fish with bones, and peach with pit), the food and associated inedible part(s) are discarded as one intact item. Generally, it is recommended to categorize these items based on the component that has the majority (approximately more than 40%) of the weight. For example, a whole egg in a shell or whole peach with a pit inside would be considered food while a mostly eaten fish with a few pieces of flesh remaining on the bones would be considered inedible parts.

When sorting food waste for waste composition studies or classifying items during the data entry process for kitchen diaries, classification into primary food categories is highly recommended. This level of categorization provides insights as to which types of food are wasted and can help determine strategies for food waste reduction interventions or measure their effectiveness. Inedible parts could be further classified into primary food categories if that level of detail is desired. However, there are generally fewer opportunities to reduce the generation of inedible parts and the focus of most food waste reduction campaigns are on the edible food portion.

Descriptions of primary food categories are presented in *Table 2* based on the categories used to estimate the baseline for Metro Vancouver's Love Food Hate Waste campaign in 2014. Common items found in each of the categories are also included to serve as a guide to help with the sorting process. During the training and supervision of sorting or data entry staff, it is very important to have consistency for how items are categorized. Sorted waste composition bins or kitchen data entry sheets should be periodically reviewed, especially at the beginning of a study to check that staff are categorizing items correctly.

TABLE 2: FOOD WASTE CATEGORIES

CATEGORY	DESCRIPTION	EXAMPLES – FOOD	EXAMPLES – INEDIBLE PARTS
VEGETABLES AND SALAD	Vegetables according to culinary definition. Includes mushrooms and fungi, roots and tubers, pulses and legumes, and seaweeds.	Eggplant, bean, broccoli, cabbage, carrot (including peel), cauliflower, celery, zucchini, cucumber, lettuce, mushroom, onion, pea, pepper, potato (including peel), spinach, sprouts, squash, corn, tomato, salad mix, mixed vegetables.	Tops of root vegetables (e.g., carrots), onion skin, hard stalks (e.g., pepper, lettuce, squash), hard vegetable peels (e.g., winter squash).
FRUIT	Fruit according to culinary definition.	Apple (including peel), banana, kiwi, melon, orange, pear (including peel), pineapple, mango, grapes, berries, stone fruits, citrus fruits, avocado, mixed fruits.	Apple core, banana peel, hard/waxy fruit peels (e.g., melon, mango), vines (e.g., grape or berries), citrus peel, stone fruit pits, avocado peel and seed.
MEAT AND FISH	All types of meat, poultry, and game products, in pieces and cuts or comminuted, fresh, and processed. Includes fresh fish and various processed fish products. Includes aquatic vertebrates (fish and aquatic mammals), aquatic invertebrates, and shellfish.	Pork, ham, bacon, beef, lamb, chicken, turkey, duck, game meat, deli meats, processed meats, fish, jellyfish, clams, snails, shrimp, crab, lobster, sea urchins, sea cucumbers.	Bones, shells, tendon, fat from cuts of meat.
BAKERY	All savory baked goods and breads. Includes uncooked dough or batter. Does not include sweet bakery items and processed snack foods.	Bread, bagels, scones, soft pretzels, croissants, pancakes, naan, filo, tortilla, breadsticks, dough, pancake batter, croutons, crisp breads, breadsticks, breadcrumbs.	None.
DAIRY/EGGS	Dairy products that are derived from the milk of any milking animal (e.g., cow, sheep, goat, buffalo). Fresh in-shell eggs, products that may substitute for fresh eggs, and other egg products. Does not include ice cream.	Milk, cheese, cream, yogurt, kefir, sour cream.	Egg shell, wax coating on cheese.
HOMEMADE/ PRE-PREPARED	Foods prepared as meals or components of meals that are mixtures of multiple categories of food. These include pre-prepared foods which require minimal preparation by the consumer (e.g., heating, thawing, rehydrating). Includes products composed primarily of protein that are derived from soybeans or from other sources.	Soup, canned soup, stew, sandwich, pasta with sauce, stir fry with meat and vegetables, salad with dressing, instant noodles, savory pie, burrito, casserole, soy burger patty, frozen dinner.	None.

TABLE 2: FOOD WASTE CATEGORIES (CONT.)

CATEGORY	DESCRIPTION	EXAMPLES – FOOD	EXAMPLES – INEDIBLE PARTS
DESSERTS	All sweet items that could be consumed at the end of a meal or a snack. Includes sweet bakery items.	Cake, cheesecake, pudding, jelly, donut, sweet pastries, sweet pies, strudel, fruit crumble, ice cream, mousse.	None.
STAPLES	Unprocessed and various processed forms of cereal and cereal-based products. Includes cooked cereal-based products if they have not been mixed with other types of food.	Breakfast cereal, flour, pasta, rice, corn flour, noodles, couscous.	Husks from milling.
CONDIMENTS/ SAUCES/SPICES	Substances added to food to enhance its aroma and taste. Includes certain prepared foods that act as sauces or condiments.	Salt and salt substitutes, soy sauce, herbs, spices, seasonings, vinegar, mustard, ketchup, salsa, mayonnaise, gravy, dips, pickles, olives, sugar, honey, jam, peanut butter.	None.
OIL/FAT	All fat-based products that are derived from vegetable, animal or marine sources, or their mixtures. Does not include fat from cuts of meat.	Butter, margarine, lard, suet, vegetable oils, flavoured oils.	None.
CANDY AND SNACKS	All cocoa and chocolate products, other candy products, chewing gum, and decorations and icings. All types of savory snack foods, nuts, and seeds.	Chocolate, candy, chewing gum, cereal bar, cookies, nuts, seeds, trail mix, popcorn, chips, crackers.	Nut and seed shells.
DRINKS	Alcoholic and non-alcoholic beverages, excluding dairy products.	Bottled water, soft drinks, coffee, fruit juice, tea, alcohol, smoothies.	Coffee grounds, tea bags.
OTHER	Items that do not fit into other categories or serve a special purpose. Includes items that are indistinguishable.	Baby food, baby formula, mixed semi-solid food, draining from canned and bottled food.	None.

The categories in *Table 2* can be aggregated or disaggregated based on the objectives and resources available for the measurement exercise. Examples of possible adaptations include:

- Aggregating inedible parts as one category and sorting edible food into detailed categories;
- Combining similar foods such as fruits and vegetables or bakery and dessert;
- Disaggregating homemade/pre-prepared meals into packaged and unpackaged; and
- Adding sub-categories for food to differentiate between whole/untouched items and leftover items.

Handling Food Waste in Packaging

Packaging with trace amounts of food waste are frequently encountered during waste audits. If there are small amounts of food waste found in packaging, do not categorize it as food waste. Generally, if the packaging represents the majority of the total weight of the item (e.g. a bread bag with a few crumbs at the bottom, peanut butter stuck to the bottom of the jar), classify the item as packaging and not as food.

To optimize sorting efficiency, if food waste is contained in lightweight packaging, it does not need to be removed during the sorting process. Typically the weight of food inside the package greatly exceeds the weight of the packaging, and therefore the packaging is negligible. Furthermore, when food is removed from lightweight packaging, some of the food may remain on the packaging and therefore result in lower weights of food waste. Examples of lightweight packaging include:

- Plastic film;
- Aluminum foil;
- Polystyrene;

- Lightweight plastic containers (e.g., clamshells, PET bottles); and
- Paper wrapping.

When food waste is contained in heavier packaging, the food items should be separated. Some discretion can be used to retain the packaging if it is difficult to remove the food items from the packaging (e.g., wet foods soaked onto a paper plate) or if the quantity of food greatly exceeds the amount of packaging (e.g., a full jar of pasta sauce). Examples of heavier packaging include:

- Glass containers;
- Metal cans;
- Durable rigid plastic containers (e.g., reusable lunch containers); and
- Fibre-based take-out containers.

Overall, between the small amounts of food that are classified as non-food (stuck on packaging) and the small amounts of packaging that are included with food waste categories, the weights generally equal out and greatly improve the efficiency of sorting.

Additional Considerations for Kitchen Diaries

The format of kitchen diaries should allow participants to record descriptions of food items that they discard along with their weights. Participants should be instructed to record separate weights for each type of food item (e.g., weigh potato peels separate from onion skins).

Participants should not be asked to categorize food items themselves, as it is an additional step in the diary recording process and categorization will likely be inconsistent due to different interpretations of what each food category means. An example of a diary page is included on *Figure 3*.

If no food or drink waste, please say why: All food consumed Meal not eaten at home Other (write in) _____

Type of Food? Please give a full description of the food or drink waste including brand. (If you run out of space you can use the overflow pages at the back of the diary.)	State? Was it cooked, prepared or served before being thrown away?		How much was diagnosed? What was the weight, volume number or amount?	Where? Please tick where it was thrown away											Why? Please give reason for disposal. Some possible answers may be:	
	Original state	Cooked/prepared/served		Food scraps & garden waste bin	Garbage bin	Backyard/home compost	Sink	Comburator	Toilet	Fed to animal	Bought too much	Cooked/served too much	Post use before date/food spoiled	Didn't like the taste		Peeling, cores, shells
	X	X		X	X	X	X	X	X	X	X	X	X	X	X	
	X	X		X	X	X	X	X	X	X	X	X	X	X	X	

Figure 3: Example Kitchen Diary Template

Coding of food descriptions into categories should be conducted by trained staff at the data entry stage. To allow for analysis of data by detailed food types (e.g., apples versus bananas), kitchen diary data should be entered with a standardized word list so it can be compiled in a consistent way. For example, participants may write ‘Granny Smith apple’, ‘apple’, ‘red apple’, or ‘apples’ in their diary. These entries should all be coded as ‘apple’.

Weight Based Measurement Method

Regardless of the study type, food waste is to be measured by weight in metric units to avoid inaccuracies associated with volume or item count conversions. Weight-based measurement also increases comparability of results between jurisdictions. For waste composition studies, weights should be recorded in kilograms to the nearest 0.05 kg. For kitchen diaries, weights should be recorded in grams to the nearest 1 gram.

If weight based measurement isn't possible, then the next best option is volumetric measurement or a visual audit. Going this route means that the accuracy of the food waste data is compromised and this will require notation or a disclaimer.

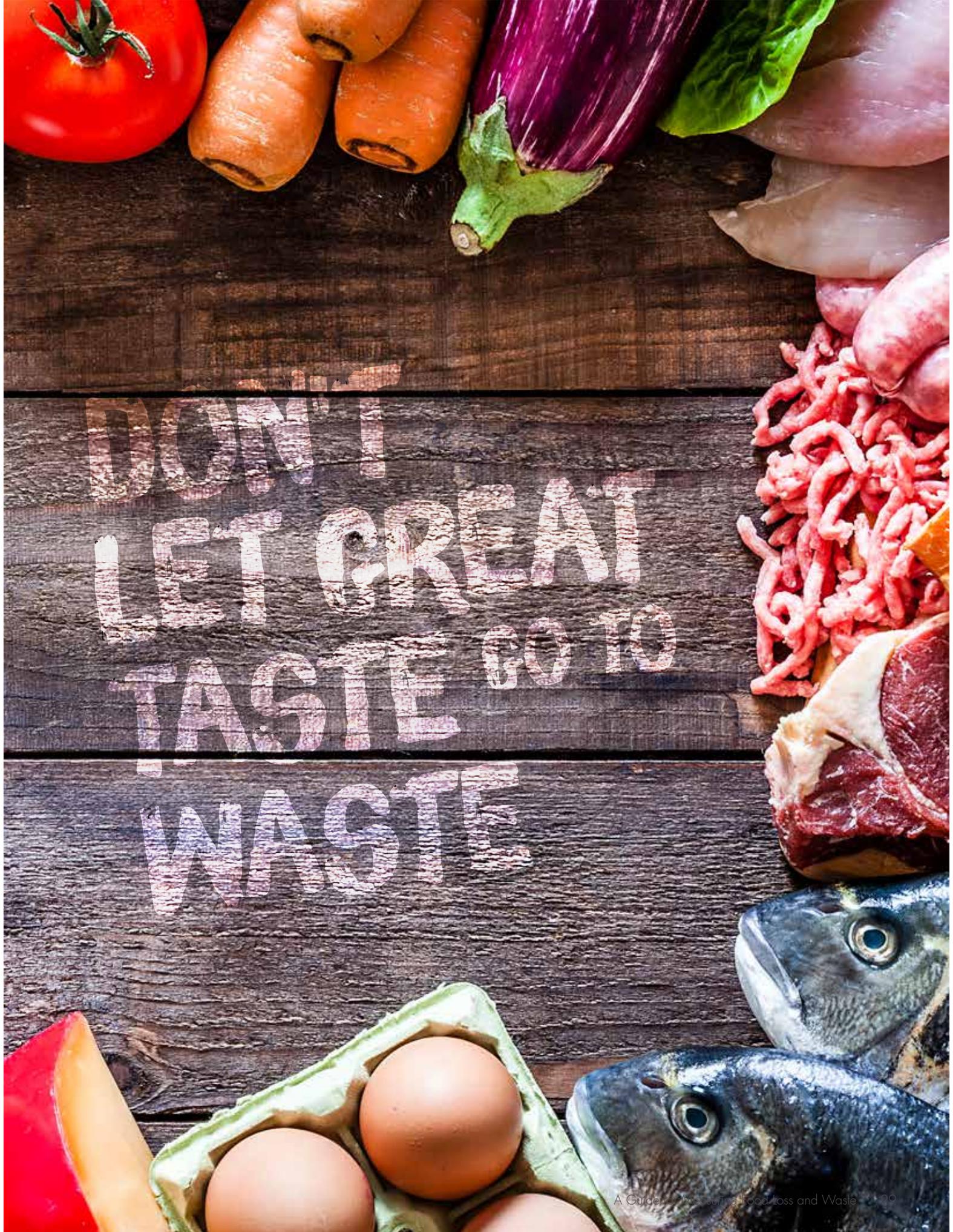


Extrapolation

Extrapolation of food waste quantification study results to estimates for a jurisdiction can be conducted in multiple ways depending on the availability of data. Methods for extrapolation based on the study conducted and available data are presented in *Table 3*.

TABLE 3: EXTRAPOLATION METHODS

STUDY TYPE	DATA COLLECTED	AVAILABLE DATA	EXTRAPOLATION METHOD
WASTE COMPOSITION STUDY (BULK OR SMALL AREA SAMPLING)	% of food waste.	Tonnage from solid waste management facilities.	Multiply % of food waste by tonnage to estimate food waste by jurisdiction.
WASTE COMPOSITION STUDY (INDIVIDUAL SAMPLING)	% of food waste.	Tonnage from solid waste management facilities.	Multiply % of food waste by tonnage to estimate food waste by jurisdiction.
	Kg of food waste per household.	Number of households.	Multiply kg of food waste per household by number of households to estimate food waste by jurisdiction.
KITCHEN DIARY	Kg of food waste per household.	Number of households.	Multiply kg of food waste per household by number of households to estimate food waste by jurisdiction.
PROXY DATA (IF UNABLE TO DO DIRECT DATA COLLECTION)	% of food waste from waste composition study in similar jurisdiction.	Tonnage from solid waste management facilities.	Multiply % of food waste by tonnage to estimate food waste by jurisdiction.
	Kg of food waste from waste composition study or kitchen diary in similar jurisdiction.	Number of households.	Multiply kg of food waste per household by number of households to estimate food waste by jurisdiction.



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Technical Appendices can be provided upon request

- Appendix A: Measurement Methods
- Appendix B: Food Waste Categories
- Appendix C: Sample Selection
- Appendix D: Extrapolation Methods

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