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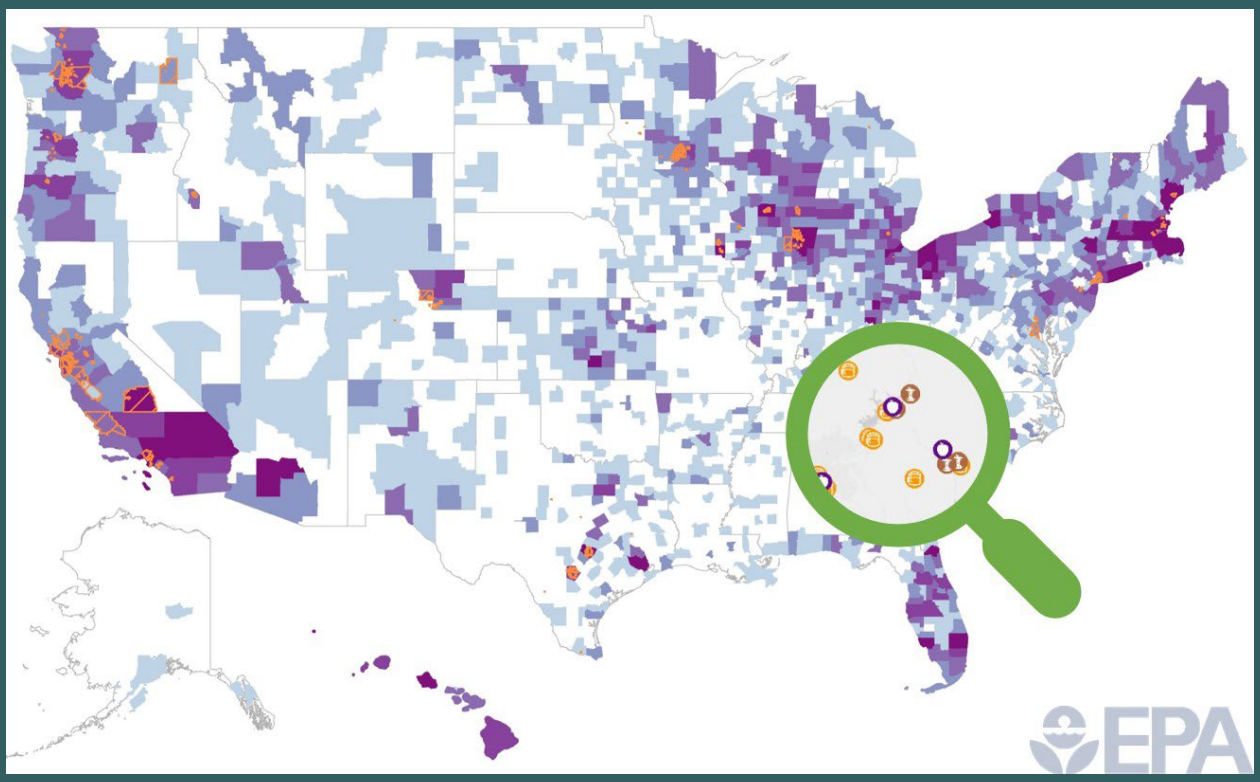
Excess Food Opportunities Map Version 3.1 – Technical Methodology



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Excess Food Opportunities Map
Version 3.1 – Technical Methodology

Office of Resource Conservation and Recovery
Office of Land and Emergency Management
Washington, DC

Abstract

This report presents the methodology behind the development of the EPA Excess Food Opportunities Map (map) Version 3.1, which supports diversion of excess food from landfills. The information presented by the map can be used to inform food recovery and waste management at the local level, and identify potential sources of organic feedstocks, infrastructure gaps, and alternatives to landfilling or incinerating excess food.

This report describes the identification of select industrial, commercial, and institutional sources in the United States that potentially generate excess food at the establishment level, and identification of potential recipients of these materials. Version 3.0 included an update of all generator and recipient datasets using mostly 2021 or more recent data. Refrigerated warehousing and storage, and farmers markets data layers were added, as well as some subsectors to existing sectors. Version 3.1 includes updates to the farmers markets, food banks, food pantries and soup kitchens, composting facilities and anaerobic digestion facilities data layers.

Based on the North American Industry Classification System (NAICS), 90 categories of industries, plus three school types, farmers markets, and food banks, food pantries and soup kitchens representing over 960,000 establishments in the US were identified as potential sources of excess food. These establishments were grouped into the following sectors: food manufacturers and processors; food wholesale and retail; educational institutions; the hospitality industry; correctional facilities; healthcare facilities; restaurants and food services; farmers markets; and food banks, food pantries and soup kitchens. Several publicly and commercially available datasets containing common business statistics for the selected industries were then compiled as a precursor to generating establishment-level excess food estimates. Methodologies developed by various states, industry groups, and non-profit organizations were reviewed to identify approaches to estimating excess food generation rates by industry. Combining select methodologies with establishment-level data resulted in a dataset that supports the map and includes over 960,000 potential excess food generators. The map also identifies almost 15,000 potential excess food recipients, including composting facilities, anaerobic digestion facilities, and food banks, food pantries and soup kitchens (food banks, food pantries and soup kitchens are considered both potential generators and potential recipients of excess food). Additionally, the map identifies infrastructure to support excess food management, including over 200 communities with residential source separated organics programs and roughly 600 refrigerated warehousing and storage facilities. Finally, Version 3.1 includes data layers for food insecurity, food assistance, and food access.

Executive Summary

This report describes the methodologies used to create estimates for the EPA Excess Food Opportunities Map (map) Version 3.0. This interactive map supports nationwide diversion of food from landfills and incinerators through the display of over 960,000 potential industrial, commercial, and institutional excess food generator locations, estimates of their excess food generation rates, and the display of almost 15,000 potential recipient locations. This map can be used to:

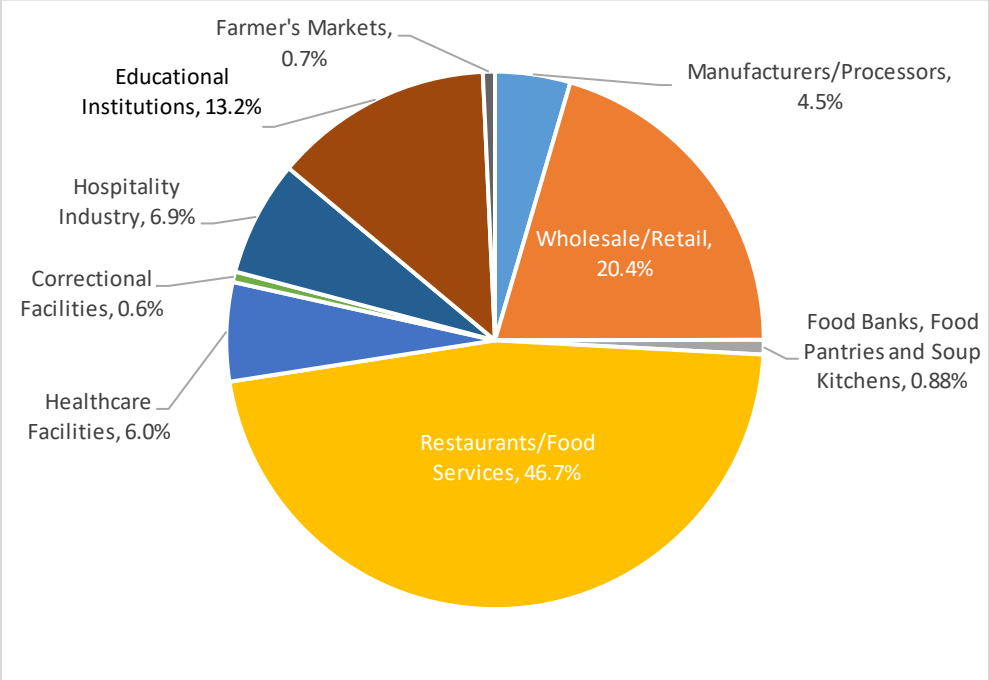
- Inform waste management decisions at the local level.
- Identify potential sources of food for rescue and recovery.
- Connect potential feedstocks to compost, anaerobic digestion, or other excess food recyclers.
- Identify potential infrastructure gaps for managing excess food.
- Identify where food recovery infrastructure, better food access, and changes to food policies may be needed, taking into account data on food insecurity, food assistance, and food access.

For the purposes of this report, "excess food" refers to food—whether processed, semi-processed, or raw—that was not used for its intended purpose and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or sending to landfills or combustion facilities. Examples of "excess food" include unsold food from retail stores; plate waste, uneaten prepared food, or kitchen trimmings from restaurants, cafeterias, and households; or by-products from food and beverage processing facilities. EPA often refers to this as "wasted food." The studies that EPA relies on in this methodology do not distinguish between food and inedible parts (e.g., pits, rinds, bones) (such as those discarded in restaurant kitchens or during processing), so inedible parts are included in EPA's estimates. Further, this report does not include data or estimates for on-farm food loss, including unharvested crops, nor excess food or other organic materials from the residential sector.

Based on the North American Industry Classification System (NAICS), 90 categories of industries, three school types, food banks/food pantries/soup kitchens and farmers markets representing over 960,000 establishments in the US were identified as potential sources of excess food. These establishments were grouped into the following sectors: food manufacturers and processors (45), food wholesale and retail (24), educational institutions (3), the hospitality industry (5), correctional facilities (1), healthcare facilities (9), restaurants and food services (6), farmers markets (1), and food banks/food pantries/soup kitchens (1). **Figure 1** shows that the restaurants and food services and food wholesale and retail sectors make up the majority of potential sources of excess food in terms of number of establishments. Commercially and publicly available data were compiled to create a dataset of all identified establishments. The dataset includes each establishment's name, location, a calculated estimated excess food generation rate, and additional information such as phone numbers and websites, where available. The dataset also includes potential recipients of

excess food, including establishment name, location, phone number, website, and feedstock accepted, where available, for composting facilities, anaerobic digestion facilities, and food banks, food pantries and soup kitchens. Data were also obtained and mapped for supporting infrastructure, including refrigerated warehousing and storage, and communities with source separated organics programs.

Figure 1. Non-Residential Excess Food Generating Sectors



Sector-specific methodologies for estimating excess food generation rates were adopted from existing studies conducted by state environmental agencies, published articles, and other sources, such as the Food Waste Reduction Alliance (FWRA). All adopted studies used methodologies based on commonly tracked business statistics to estimate excess food generation rates for several or all the targeted sectors. These business statistics include number of employees, annual revenue, number of students (for educational institutions), capacity (for correctional facilities), and number of beds (for healthcare facilities).

Using establishment-specific statistics collected in the dataset, the methodologies were used to estimate the amount of excess food from each establishment in each of the targeted sectors. A range of excess food estimates was calculated for each establishment, and the high and low estimates are displayed in the map and dataset.

The map and methodologies are not intended to provide accurate nation-wide estimates of excess food generation, nor do they reflect establishment-specific recovery or recycling efforts. Rather, they are intended to show estimated generation amounts, potential sources and possible recipients of excess food. This information may be used to help the public and private sectors divert excess food from landfills and incinerators and toward more preferred uses as reflected in EPA's Wasted Food Scale (e.g., donation, upcycling, animal feed, anaerobic digestion, composting).

Acknowledgements

Development of Version 3.1 of the map was led by Claudia Fabiano (Office of Land and Emergency Management) and Juliana Beecher (Oak Ridge Institute for Science and Education fellow). The map application development was led by Katie Krueger and Stacy Takeda (EPA Region 9) with support from Jenny Herring and Jarod Martin of Innovate! Inc.

Notice

This report has been internally peer reviewed by the US Environmental Protection Agency Office of Land and Emergency Management. Mention of trade names or commercial products does not constitute endorsement or recommendation by EPA for use.

Contents

List of Figures

List of Tables

List of Abbreviations, Acronyms, and Initialisms

BJS	Bureau of Justice Statistics
BSR	Business for Social Responsibility
CCG	Cascadia Consulting Group
DHS	Department of Homeland Security
DnB	Dun & Bradstreet, Inc.
EPA	Environmental Protection Agency
ERS	Economic Research Service
FWRA	Food Waste Reduction Alliance
ICI	Industrial, Commercial, and Institutional
lbs	Pounds
MSW	Municipal Solid Waste
NAICS	North American Industry Classification System
NCDENR	North Carolina Department of Environment and Natural Resources
NCES	National Center for Education Statistics
NRDC	Natural Resources Defense Council
NSLP	National School Lunch Program
SCDOC	South Carolina Department of Commerce
ton	Short Ton (wet)
UNEP	United Nations Environment Program
US	United States
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture

1. Introduction

1.1. Background

In 2015, in alignment with Target 12.3 of the United Nations Sustainable Development Goals, the United States Department of Agriculture (USDA) and United States Environmental Protection Agency (EPA) announced the first ever domestic goal to reduce food loss and waste by half by the year 2030. The EPA Excess Food Opportunities Map (map) is a tool intended to support achievement of this goal.

The United Nations Environment Program (UNEP) estimates that approximately one third of food produced for human consumption is excess (UNEP (n.d.)). EPA estimates that in 2019, 66.2 million tons of wasted food was generated in the food retail, food service, and residential sectors; an additional 40.1 million tons of wasted food was generated in the food manufacturing and processing sector (EPA (2023a)). When food is wasted, it also wastes the resources – such as the land, water, energy, and labor – that go into growing, storing, processing, distributing, and preparing that food. Each year, food loss and waste from farm to kitchen embodies an area of agricultural land the size of California and New York combined, enough energy to power 50 million US homes for a year, and emissions (excluding landfill emissions) equal to the annual CO2 emissions of 42 coal-fired power plants (EPA (2021)).

EPA estimates that excess food generated from the food retail, food service, and residential sectors represents approximately 21.6% (i.e., 63.1 million tons) of all Municipal Solid Waste (MSW) generated in 2018 (US EPA (2020)). In 2019, approximately 74% of food included in the municipal solid waste stream was either landfilled or incinerated, while the remainder was managed in other ways including donation, animal feed, composting, and anaerobic digestion (US EPA (2023a)). When food ends up in landfills, it releases methane, a powerful greenhouse gas. Landfills are the third largest anthropogenic source of methane emissions in the United States (119.8 MMT CO2 Eq.), accounting for 17.1 percent of total methane emissions in 2022 (US EPA (2024)). Food waste is responsible for 58% of fugitive methane emissions from landfills, and 61% of methane from landfilled food waste is emitted before landfill gas capture systems are installed (US EPA (2023b)). Therefore, diverting excess food from landfills where it might degrade before gas collection is implemented could significantly reduce the production of greenhouse gas emissions.

The definition of excess food varies across studies and among organizations, resulting in different estimates of excess food. For example, the USDA considers only the edible fraction in its accounting of "food losses" as its focus is on improving human nutrition (USDA (2014)). For the purposes of this report, "excess food" refers to food—whether processed, semi-processed, or raw—that was not used for its intended purpose and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or sending to landfills or incinerators. EPA often refers to this as "wasted food." The studies that EPA relies on in this methodology do not distinguish between food and inedible parts (e.g., pits, rinds, bones) (such as those discarded in restaurant kitchens or during processing), so inedible parts are included in EPA's estimates. The map does not include on farm food loss such as unharvested or excess food, nor excess food and other organic material from the residential sector.

To prioritize efforts to divert excess food, EPA created the Wasted Food Scale (**Figure 2**) (US EPA (2023c)). Preventing food from going to waste in the first place is the most preferred option as it not only mitigates the environmental impacts associated with management of excess food, but also minimizes the impacts associated with food production, processing, and delivery to the end-user. Donating and upcycling food are the next-best options, since both put food to its best use: to nourish humans. Any other management option chosen in a particular situation is dependent on the characteristics and the source of the excess food, as well as the available infrastructure in the area. For example, some food preparation residuals and/or post-consumer food discards may not be suitable for human consumption, so the next most preferred use is for animal feed. Landfilling, incinerating, and sending food down the drain are the least preferred options for managing excess food because they have the largest environmental impacts and recover the least value from excess food. Currently, eleven states and eleven localities have some form of an organic waste ban, waste recycling law, or donation requirement that pertains to food, and there is growing interest in the practice (ReFED (2024)). In 2021 alone, 25 states introduced food waste-related legislation (Harvard Food Law and Policy Clinic (2022)). Private sector businesses have made strides in setting goals, measuring and reducing excess food, and communities are increasingly focused on education and awareness efforts aimed at helping their residents waste less food at home.

Figure 2: Wasted Food Scale

At the national level, EPA has developed tools and resources for measuring, tracking, and reducing excess food, and has assessed the cost and environmental impacts of excess food management (US EPA (2016)). EPA research on the environmental impacts and economic costs of wasted food is ongoing, including reports on the environmental impacts of wasted food from farm to kitchen (2021) and in common food waste management pathways (2023c), as well as methane emissions from landfilled food waste (2023b). The Agency also regularly publishes estimates of wasted food in the US (US EPA (2023a)). Additional research goals are laid out in the National Strategy for Reducing Food Loss and Waste and Recycling Organics (US EPA et al. (2024)). EPA recognizes the need for tools to support a broader understanding of potential excess food generation, and to foster collaboration and partnership among stakeholders interested in promoting and achieving sustainable management of food. EPA continues to support public and private sector efforts, facilitate peer learning, provide data and conduct research to help decision makers, and provide funding to support waste reduction efforts. Notably, in 2022, EPA established funding opportunities through the Solid Waste Infrastructure for Recycling Grant Program and Recycling Education and Outreach Grant Program for a total of $350 million (US EPA (2022)).

1.2. Objectives and Approach

The primary objective of this report is to present the methodology used to develop and update the Excess Food Opportunities Map and dataset, including establishment-specific estimates of excess food generation. This national-scale, interactive map is intended to help inform food recovery and waste management decisions at the local level, and identify potential sources of organic feedstocks, infrastructure gaps, and alternatives to landfill or combustion. EPA used the following approach to develop Version 3.0:

- Using the North American Industry Classification System (NAICS), 90 categories of industries, plus three school types, farmers markets, and food banks, food pantries and soup kitchens representing over 960,000 establishments in the US were identified as potential sources of excess food. These establishments were grouped into the following sectors: food manufacturers and processors (45), food wholesale and retail (24), educational institutions (3), the hospitality industry (5), correctional facilities (1), healthcare facilities (9), restaurants and food services (6), farmers markets (1), and food banks/food pantries/soup kitchens (1).
- A literature review informed development of methodologies used to estimate excess food generation factors for each sector (further details are provided in Section 2).
- Publicly and commercially available data sources were mined for supplementary data to estimate establishment-level excess food generation rates using the identified methodologies. The resulting dataset was used to support the online map.
- Information about potential recipients of excess food was also collected and mapped, and includes food banks, food pantries and soup kitchens, composting facilities, and anaerobic digestion facilities.
- Information about infrastructure that supports excess food management was also collected and mapped, including refrigerated warehousing and storage facilities, and communities with residential source separated organics programs.
- Data layers on food insecurity and food assistance from USDA's Food Environment Atlas, and data layers from USDA's Food Access Research Atlas were brought in to add additional capabilities to the map.

The resulting map provides establishment-level information such as name, geographic location, and physical address, and where possible, estimates of excess food generation. The map also includes similar establishment-level information about potential recipients of excess food that also comes primarily from publicly and commercially available datasets, as well as state websites (more details provided in Section 4).

2. Sector-Specific Data Sources and Excess Food Estimation Methodologies for Generators

2.1. Overview

This chapter describes the methods and data sources used to estimate the excess food generation rates for individual establishments in the 90 identified industrial, commercial, and institutional (ICI) industries, three school types, farmers markets, and food banks, food pantries and soup

kitchens. For the purposes of this report, "excess food" refers broadly to food that was not used for its intended purpose and is managed in a variety of ways. EPA often refers to this as "wasted food." The map does not include on farm food losses such as unharvested crops nor excess food or other organic material from the residential sector.

These 90 industrial, commercial, and institutional (ICI) industries, plus three school types, farmers markets, and food banks, food pantries and soup kitchens were grouped into the following sectors: food manufacturers and processors (45), food wholesale and retail (24), educational institutions (3), the hospitality industry (5), correctional facilities (1), healthcare facilities (9), restaurants and food services (6), refrigerated warehousing and storage (1), farmers markets (1), and food banks/food pantries/soup kitchens (1). The list of industries and establishments included can be found in each sector's respective section.

Establishment-level data for most industries came from DnB and included contact information, location details (geo-coordinates and physical addresses), establishment type (headquarters, branch, or single location), revenue ($USD), and number of employees. Similar establishment-level data for educational institutions was obtained from the National Center for Education Statistics (NCES (2021a), (2021b), (2021c)), and data for healthcare facilities and correctional facilities was obtained from the US Department of Homeland Security (DHS (2020)). Farmers market data was obtained from USDA (USDA (2022)). Data on food banks, food pantries and soup kitchens were obtained from Hunger Free America (2024).

In general, sector-specific methodologies for estimating excess food generation rates were adopted from existing studies conducted by state environmental agencies, published articles, and other sources, such as the Food Waste Reduction Alliance (FWRA). All adopted studies used methodologies based on commonly tracked business statistics to estimate excess food generation rates for several or all the targeted sectors. These business statistics include number of employees, annual revenue, number of students (for educational institutions), capacity (for correctional facilities) and number of beds (for healthcare facilities).

Using establishment-specific statistics collected in the dataset, the methodologies were used to estimate the amount of excess food from each establishment in each of the targeted sectors. Where more than one methodology was available for a sector, a range of excess food estimates was calculated for each establishment, and the high and low estimates are displayed in the map and dataset. If only one methodology was available for a sector, then one estimate is displayed in the map and dataset. The excess food estimates include edible as well as inedible food to the extent accounted for by the studies. EPA did not attempt to estimate the portions of excess food estimates that are potentially recoverable for human consumption. If data were not available to generate an excess food estimate, the establishment was still mapped, but no estimate is provided. Data were available to calculate estimates for 89.4% of establishments in Version 3.1 of the map.

2.2. Food Manufacturers and Processors

Forty-five industries are included as food manufacturers and processors (**Table 1**).

Table 1. NAICS Codes for Food Manufacturers and Processors

No.	NAICS Code	NAICS Code Description
1	311211	Flour Milling
2	311212	Rice Milling
3	311213	Malt Manufacturing
4	311221	Wet Corn Milling
5	311224	Soybean and Other Oilseed Processing
6	311225	Fats and Oils Refining and Blending
7	311230	Breakfast Cereal Manufacturing
8	311313	Beet Sugar Manufacturing
9	311314	Cane Sugar Manufacturing
10	311340	Non-chocolate Confectionery Manufacturing
11	311351	Chocolate and Confectionery Manufacturing from Cacao Beans
12	311352	Confectionery Manufacturing from Purchased Chocolate
13	311411	Frozen Fruit, Juice, and Vegetable Manufacturing
14	311412	Frozen Specialty Food Manufacturing
15	311421	Fruit and Vegetable Canning
16	311422	Specialty Canning
17	311423	Dried and Dehydrated Food Manufacturing
18	311511	Fluid Milk Manufacturing
19	311512	Creamery Butter Manufacturing
20	311513	Cheese Manufacturing
21	311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing
22	311520	Ice Cream and Frozen Dessert Manufacturing
23	311611	Animal (except Poultry) Slaughtering
24	311612	Meat Processed from Carcasses
25	311613	Rendering and Meat Byproduct Processing
26	311615	Poultry Processing
27	311710	Seafood Product Preparation and Packaging
28	311811	Retail Bakeries
29	311812	Commercial Bakeries
30	311813	Frozen Cakes, Pies, and Other Pastries Manufacturing
31	311821	Cookie and Cracker Manufacturing
32	311824	Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour
33	311830	Tortilla Manufacturing
34	311911	Roasted Nuts and Peanut Butter Manufacturing
35	311919	Other Snack Food Manufacturing
36	311920	Coffee and Tea Manufacturing
37	311930	Flavoring Syrup and Concentrate Manufacturing
38	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing

39	311942	Spice and Extract Manufacturing
40	311991	Perishable Prepared Food Manufacturing
41	311999	All Other Miscellaneous Food Manufacturing
42	312111	Soft Drink Manufacturing
43	312120	Breweries
44	312130	Wineries
45	312140	Distilleries

The literature search identified a total of 55 studies examining excess food generation at the food manufacturing and processing level. Many of these studies, however, are not directly useful to methods development as some lack quantitative information on generation rates, while others apply generation rates from earlier studies. EPA chose three studies that involved original research (e.g., surveying food manufacturers/directly measuring excess food generated from a sample of food manufacturers) (**Table 2**). These three studies were used to estimate excess food generated, resulting in a range of values for each facility.

Table 2. Generation Factors for Manufacturers and Processors

SOURCE	YEAR	GENERATION FACTOR	UNIT
FWRA	2016	0.17	lbs/revenue/year
BSR	2014	0.053	lbs/revenue/year
BSR	2013	0.062	lbs/revenue/year

These three studies establish generation factors based on pounds of excess food generated per dollar of sales revenue per year. The 2013 and 2014 studies were developed by BSR for the FWRA, while the 2016 study was published with FWRA as the author. These three studies are heavily cited in other research (see NRDC (2017); Garcia-Garcia (2016); ReFED (2016)). The studies estimated generation rates by surveying food manufacturers and processors around the nation. Depending on the year of the survey, the surveyed manufacturers and processors represent anywhere between 6.2 percent to 17 percent of the national food manufacturing/processing industry, based on sales. The facilities included in the studies vary each year; because the samples change, the studies are independent, so all three studies were used. The three generation rates from the studies range from 0.053 to 0.17 pounds per dollar of annual industry sales revenue. It should be noted that these studies do not contain specific generation factors for each type of manufacturer or processor, and that excess food generation can vary depending on the type of industry (for example, cane sugar manufacturing and meat processors likely produce different amounts of excess food). Therefore, due to the absence of NAICS code-specific excess food generation factors, these generation factors were applied to all facilities across all 45 NAICS codes. The three generation factors were used in conjunction with establishment-level annual revenue data obtained from DnB to estimate the annual amount of excess food generated by food manufacturing and processing facilities. This is reflected in the following equation:

$$\text{Food Manufacturers and Processors Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Facility's Annual Revenue (\$)} \times X \frac{\text{lb}}{\text{Annual Revenue (\$)}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 0.17, 0.053, or 0.062

2.2.1 Changes in Version 3.1

No changes were made in Version 3.1.

2.3. Food Wholesale and Retail

2.3.1. Overview

Twenty-four industries were included, at least partially[1], under food wholesale and retail (**Table 3**). Establishments with NAICS codes starting with 424 were classified as food wholesale, and those with NAICS codes starting with 423, 445, 452, 453, and 493 were classified as food retail (i.e., supermarkets, grocery stores, and supercenters). Establishment-level data for this sector was obtained from DnB.

Table 3. NAICS Codes for Food Wholesalers and Retailers

No.	NAICS Code	NAICS Code Description
1	423990[1]	Other Miscellaneous Durable Goods Merchant Wholesalers
2	424410	General Line Grocery Merchant Wholesalers
3	424420	Packaged Frozen Food Merchant Wholesalers
4	424430	Dairy Product (except Dried or Canned) Merchant Wholesalers
5	424440	Poultry and Poultry Product Merchant Wholesalers
6	424450	Confectionery Merchant Wholesalers
7	424460	Fish and Seafood Merchant Wholesalers
8	424470	Meat and Meat Product Merchant Wholesalers
9	424480	Fresh Fruit and Vegetable Merchant Wholesalers
10	424490	Other Grocery and Related Products Merchant Wholesalers
11	445110	Supermarkets and Other Grocery (except Convenience) Stores
12	445120	Convenience Stores
13	445210	Meat Markets
14	445220	Fish and Seafood Markets
15	445230	Fruit and Vegetable Markets
16	445291	Baked Goods Stores

[1] Target, Walmart, BJ's, Costco, and Sam's Club were specifically searched for within DnB (since they are not all classified as 452311) and added; they fall under the following NAICS codes: 423990, 452210, 452319, 453998, 493110, 493190. However, only those specific stores were included for those six NAICS codes, the remainder of the establishments classified under those six NAICS codes in DnB were not included as they are not expected to be food retailers.

17	445292	Confectionery and Nut Stores
18	445299	All Other Specialty Food Stores
19	452210[1]	Department Stores
20	452311	Warehouse Clubs and Supercenters
21	452319[1]	All Other General Merchandise Stores
22	453998[1]	All Other Miscellaneous Store Retailers
23	493110[1]	General Warehousing and Storage
24	493190[1]	Other Warehousing and Storage

Notes:

1. Target, Walmart, BJ's, Costco, and Sam's Club were specifically searched for within DnB (since they are not all classified as 452311) and added; they fall under the following NAICS codes: 423990, 452210, 452319, 453998, 493110, 493190. However, only those specific stores were included for those six NAICS codes, the remainder of the establishments classified under those six NAICS codes in DnB were not included as they are not expected to be food retailers.

2.3.2. Food Wholesale

For purposes of this map, food wholesalers are those with NAICS codes 424410 through 424490. The literature search identified 22 studies examining excess food generation among food wholesalers. Many of these studies, however, are not directly useful for methods development. Some lack quantitative information on generation rates, while others apply generation rates from earlier studies. Two studies conducted by CCG defined the wholesale sector broadly, grouping food wholesalers with other non-durable wholesalers such as apparel and chemicals. Given that these other non-durables differ greatly from food in their waste generation patterns, EPA excluded the two CCG studies. EPA chose one study that focused on food wholesale and involved original research (e.g., direct analysis of facilities' excess food) (**Table 4**). This study was used to estimate excess food generated, resulting in one value for each establishment.

Table 4. Generation Factors for Food Wholesale Facilities

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNIT
1	BSR	2014	0.005	Tons/thousand $ revenue

BSR (2014) collected industry generation data through a series of surveys, and the generation factor is shown below:

$$\text{Food Wholesalers Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Establishment's Annual Revenue \$} \times 0.005 \frac{\text{tons}}{\text{thousand \$ revenue}}$$

2.3.3. Food Retail (Supermarkets, Grocery Stores, Supercenters)

For purposes of this map, food retailers are those establishments classified under NAICS codes 445110, 445120, 445210, 445220, 445230, 445291, 445292, 445299, and 452311 as well as Target, Walmart, BJ's, Costco, and Sam's Club stores.[2] EPA chose seven studies that involved original research (e.g., direct analysis of facilities' excess food) (**Table 5**). These seven studies were used to estimate excess food generated, resulting in a range of values for each establishment.

Table 5. Generation Factors for Food Retail (Supermarkets, Grocery Stores, and Supercenters)

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNIT	ESTABLISHMENT TYPE
1	CCG	2006	2.31	Tons/employee/ year	Supermarket/Grocery Store
2	Kessler Consulting	2012	2.32	Tons/employee/ year	Supermarket/Grocery Store
3	CCG	2015	2.02	Tons/employee/ year	Supermarket/Grocery Store
4	Draper/Lennon	2001	1.5	Tons/employee/ year	Supermarket/Grocery Store
5	CCG	2006	0.27	Tons/employee/ year	Supercenter
6	ReFED	2016	0.5	Tons/employee/ year	Supercenter
7	BSR	2014	0.005	tons/thousand $ revenue	Supermarket/Grocery Store

In the relevant literature, several studies provide separate generation rates for supermarkets/grocery stores and supercenters. Supercenters are defined as large retail establishments that sell a complete line of grocery merchandise in addition to non-grocery goods. Supercenters include big-box stores, such as Wal-Mart and Target and warehouse clubs such as BJs, Sam's Club, and Costco. Supermarkets/grocery stores and supercenters exhibit different characteristics regarding the sale of food. Most notably, supercenters often sell food items in bulk and at a lower unit price relative to supermarkets.

CCG (2006) and CCG (2015) conducted audits of food retail sector waste. Draper/Lennon (2001), Kessler Consulting (2012), BSR (2014), and ReFED (2016) collected data through a series of surveys and interviews with store managers and other experts.

The five studies containing generation factors 1-6 estimated generation factors between 0.27 and 2.32 tons per employee per year. The low generation factor was reported by CCG (2006), which sampled waste at big-box retail stores. Another low generation factor, 0.5 tons per employee per

[2] Target, Walmart, BJ's, Costco, and Sam's Club were specifically searched for within DnB (since they are not all classified as 452311) and added; they fall under the following NAICS codes: 423990, 452210, 452319, 453998, 493110, 493190. However, only those specific stores were included for those six NAICS codes, the remainder of the establishments classified under those six NAICS codes in DnB were not included as they are not expected to be food retailers.

year, was reported by ReFED (2016), who interviewed supercenters to estimate excess food per employee. Generation rates for supercenters are likely lower than those for supermarkets/grocery stores because they take into account all employees, not just the grocery department employees. The higher supermarket/grocery store estimates were provided by CCG (2006) and Kessler Consulting (2012), who conducted waste audits at supermarkets.

The 7th study quantifies excess food generated on a revenue basis. BSR (2014) collected industry generation data through a series of surveys and estimated 10 pounds of excess food per thousand dollars of company revenue (or 0.005 tons per thousand dollars of revenue).

Generation factors 1-4 and 7 were applied to establishments classified as supermarkets and grocery stores (i.e., those with NAICS codes starting with 445). Generation factors 5 and 6 were applied to establishments classified as supercenters (i.e., NAICS code 452311, and Target, Walmart, Costco, Sam's Club, and BJ's establishments). These generation factors were used to calculate a range of excess food estimates for supermarkets, grocery stores, and supercenters.

Generation factors 1-6 were used in conjunction with employee data obtained from DnB and use the following equation:

$$\text{Food Retailers Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) = \text{Number of employees} \times \frac{X\frac{\text{tons}}{\text{employee}}}{\text{year}}$$

Where X = 0.27 to 2.32

Generation factor 7 was used in conjunction with revenue data obtained from DnB and uses the following equation:

$$\text{Food Retailers Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Establishment's Annual Revenue } \$ \times 0.005 \frac{\text{tons}}{\text{thousand } \$ \text{ revenue}}$$

2.3.4. Changes in Version 3.1

No changes were made in Version 3.1

2.4. Educational Institutions

2.4.1. Overview

The educational institutions sector consists of three types of schools: postsecondary (i.e., colleges, universities, and professional schools), public elementary and secondary schools, and private elementary and secondary schools (**Table 6**). Data were obtained from the National Center for Education Statistics (NCES); NAICS codes are not used in NCES databases.

Table 6. Educational Institutions – School Types

No.	School Type
1	Postsecondary Schools
2	Public Elementary and Secondary Schools
3	Private Elementary and Secondary Schools

2.4.2. Postsecondary Schools

Data for postsecondary schools were collected from the Integrated Postsecondary Education Data System of the NCES for the 2020 school year (NCES (2021a)). These data include the name, school type, address, geo-coordinates, phone number, website, and total enrollment of each institution.

The literature search identified a total of 44 studies addressing excess food generation in postsecondary school settings. Many of these studies, however, are not directly useful to methods development. Some studies lack quantitative information on generation factors, while others apply generation factors from earlier studies. Therefore, EPA chose ten studies that either involved original research (e.g., directly weighing plate waste at a college dining hall) or which present estimates widely cited in the literature (Table 7). These ten studies were used to estimate excess food generated, resulting in a range of values for each institution.

Table 7. Generation Factors for Postsecondary Schools

GENERATION FACTOR #	SOURCE	YEAR	UNITS	GENERATION FACTOR		
				PRE-CONSUMER[1]	POST-CONSUMER	TOTAL
1	Ebner et al.	2014	lbs/meal	0.07	0.15	0.22
2	Sarjahani et al.[2]	2009	lbs/meal	0.19	0.23	0.42
3	Vannet Group	2008	lbs/meal	0.16	0.31	0.47
4	Graunke and Wilke	2008	lbs/meal	0.16	0.19	0.35
5	Draper/Lennon	2001	lbs/meal	N/A	N/A	0.35
6	Thiagarajah and Getty	2013	lbs/meal	0.16	0.25	0.40
7	Whitehair et al.[3]	2013	lbs/meal	0.09	0.14	0.23
8	Kim and Morawski[2]	2012	lbs/meal	0.13	0.21	0.34
9	Caton et al.	2010	lbs/meal	0.31	0.49	0.79
10	CCG	2015	lbs/student/year	N/A	N/A	22.0

Notes:

1. Pre-consumer values are estimated for generation factors 6-9 using the average proportion of pre-consumer excess food from studies 1-5. On average, studies 1-5 showed post-consumer excess food to be 61.4 percent of all waste.
2. Sarjahani et al. (2009) and Kim and Morawski (2012) estimate excess food generation with and without trays. EPA uses the average of the two estimates.

3. Whitehair et al. (2013) studies the effect of a messaging campaign to reduce excess food. EPA uses the baseline data as the basis for this generation factor.

Generation factors 1-5 use direct estimates of excess food generation per meal, including pre-consumer food (i.e., excess food in the kitchen or from preparation) as well as post-consumer food (i.e., plate waste). The highest generation factor is from Vannet Group (2008), yielding an estimate of 0.47 pounds per meal. EPA includes this study because it weighed excess food at all stages of the dining process, including the kitchen prep area, food serving stations, and consumer stations. Ebner et al. (2014), Sarjahani et al. (2009), and Graunke and Wilke (2008) conducted original research on excess food generated from college/university dining halls. EPA also included one study that did not directly measure excess food generation, Draper/Lennon (2001), because it is widely cited in the literature.[3]

The literature search also identified four additional high-quality studies that analyze only post-consumer excess food (i.e., plate waste). Studies 6-9 have a larger range between the lowest estimate from Whitehair et al. (2013) of only 0.14 pounds per meal, and the highest estimate from Caton et al. (2010) of 0.49 pounds per meal. Because these studies only consider post-consumer excess food, EPA scaled the post-consumer excess food generation factors upward using the average proportion of the excess food generated from post-consumer excess food in studies 1-5 to estimate a total excess food generation factor. On average, studies 1-5 showed post-consumer excess food to be 61.4 percent of all excess food. Applying this figure to the post-consumer values in studies 6-9 yields an estimate of total excess food generation per meal. For instance, dividing the Whitehair et al. (2013) estimate of 0.14 pounds per meal by 0.614 provides a total excess food estimate (pre- and post-consumer) of 0.23 pounds per meal. The pre-consumer values in Table 7 are simply the total excess food generation factor minus the post-consumer factor.

Generation factor 10 frames generation in terms of pounds per student per year and is estimated from one source, CCG (2015). While CCG (2015) does not differentiate between the K-12 and college/university sectors, EPA included the generation factor derived from "education sector" because the study is recent, and the estimates are derived through direct waste sampling. EPA also used the same generation factor for elementary and secondary schools.

The NCES database did not provide the number of meals served at each institution, so to use the generation factors that are based on pounds per meal (1-9), EPA searched for studies that contained data on how many meals, on average, each student consumes per year at postsecondary institutions.

- **Meals per Residential Student per Year** – Students living on campus consume more food on campus than non-residential students. Draper/Lennon (2001) applied two separate "meals per enrolled student per year" estimates for residential and non-residential institutions. Specifically, they assumed a total of 405 meals per residential student per year. Two additional studies provide data on the number of meals served per

[3] See NRDC (2017), Hodge et al. (2016), Moriarty (2013), Wellesley College (2013), and US EPA (2011).

enrolled student per year at residential institutions.[4] The analysis calculates the average meals per enrolled student at residential institutions as the average of the three estimates, equal to 285 meals per enrolled student per year.

- **Meals per Non-Residential Student per Year –** Lacking additional data on meals served per enrolled student at non-residential institutions, EPA retained the Draper/Lennon (2001) value of 108 meals per enrolled student at non-residential institutions.
- **Weighted Average Meals per Student –** EPA estimated a national average of 169 meals served per enrolled student as the average meals served per enrolled student between residential and non-residential institutions, weighted by the percent of students attending residential institutions and non-residential institutions.[5]

Generation factors 1 through 9 use the following equation:

$$\text{Postsecondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{169 \dfrac{\text{meals}}{\text{student}}}{\text{year}} \times \text{X} \frac{\text{lbs}}{\text{meal}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 0.22 to 0.79

Generation factor 10 is based on pounds per student per year, and uses the following equation:

$$\text{Postsecondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{22 \dfrac{\text{lbs}}{\text{student}}}{\text{year}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

2.4.3. Elementary and Secondary Schools

Data for elementary and secondary schools were collected from NCES for the 2020-2021 school year. Public school data were obtained from the NCES Table Generator for the 2020-2021 school year (NCES (2021b)) and included institution name, address, phone number, website, geo-coordinates, school level (elementary, middle, high school, and others), and the total student enrollment for each institution. Private school data were obtained from the NCES Table Generator

[4] Ebner et al. (2014) reported two an average of 226 meals per student per year. estimates: 180 and 270 meals per enrolled student per year according to two different methods. EPA used the average (225) as representative of Ebner et al (2014). Whitehair et al. (2013) reported 19,046 meals served at a dining hall serving 540 students over a six-week period. Assuming an academic calendar of 270 days following Draper/Lennon (2001), EPA estimated an average of 226 meals per student per year.

[5] EPA estimated that 34 percent of all enrolled students attend residential institutions. EPA calculated the percent of enrolled students attending residential institutions as sum of enrolled students at "primarily residential" and "highly residential" institutions divided by the total number of enrolled students. See the Classification Summary Tables, Carnegie Classification of Institutions of Higher Education, Center for Postsecondary Research, Indiana University School of Education, available at: http://carnegieclassifications.iu.edu/downloads.php.

for the 2017-2018 school year (NCES (2021c)) and included institution name, address, phone number, geo-coordinates, and the total number of students enrolled for each institution.

The literature search identified a total of 32 studies addressing excess food generation in the K-12 school setting. Many of these studies, however, are not directly useful to methods development. Some lack quantitative information on generation factors, while others apply generation factors from earlier studies. Therefore, EPA chose five studies that either involved original research (e.g., waste audits at an elementary school) or that present estimates widely cited in the literature and applied them to both public and private elementary and secondary schools (**Table 8**).

Table 8. Generation Factors for Public and Private Elementary and Secondary Schools

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNITS
1	Wilkie et al.	2015	25.9	lbs/student/year
2	RecyclingWorks Massachusetts	2013	18.0	lbs/student/year
3	CCG	2015	22.0	lbs/student/year
4	Byker et al.	2014	0.52	lbs/meal
5	Draper/Lennon	2001	0.35	lbs/meal

Generation factors 1, 2, and 3 use pounds per student per year. Wilkie et al. (2015) estimate an average generation factor of 25.9 pounds per student per year based on sampling at three different Florida schools.[6] RecyclingWorks Massachusetts (2013) estimated an average generation factor of 18.0 pounds per student per year, based on waste audits conducted at seven public elementary, middle, and high schools and serves as the low estimate. CCG (2015) estimates a generation factor of 22.0 pounds per student per year.[7]

Generation factors 4 and 5 use pounds (per student) per meal. Byker et al. (2014) estimated an average generation factor of 0.52 pounds per meal at public pre-kindergarten and kindergarten classes. EPA also included one study that did not directly measure excess food generation at typical K-12 schools, Draper/Lennon (2001), because it is widely cited in the literature.[8] Draper/Lennon (2001) estimated an average of 0.35 pounds of excess food per meal.

The Wilkie et al. (2015) and Byker et al. (2014) studies differentiate between excess food and milk waste. The recommended methods incorporate both excess food and milk waste, implicitly assuming that students dispose of milk in the same trash receptacles as food.

Generation factors 1, 2, and 3 are based on pounds per student per year, and use the following equation:

[6] The three schools include one public elementary school, one public high school, and one private middle/high school.

[7] CCG (2015) reported a generation rate of 3.67 tons of *total* waste per year per 100 students in Table 39. This is converted to excess food using the estimated percentage of total waste that is food of 30.0 percent, from Table 40. As noted earlier, the CCG study pools all educational institutions, including colleges/universities and K-12 schools. EPA applied the same generation factor in both sectors.

[8] Draper/Lennon (2001) estimated excess food generation at colleges, universities, and independent preparatory schools. Cited in South Carolina Department of Commerce (2015), Mercer (2013), BSR (2012), and US EPA (2011).

$$\text{Elementary and Secondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{\text{X}\,\frac{\text{lbs}}{\text{student}}}{\text{year}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 18.0, 22.0 or 25.9

The NCES database did not provide the number of meals served at each institution, so in order to use generation factors 4 and 5 that are based on pounds per meal, EPA used data released from the National School Lunch Program (NSLP), which reports the total number of students enrolled in the program and the number of meals served per year.[9] The result is an average of 164 meals per student per year. Generation factors 4 and 5 use the following equation:

$$\text{Elementary and Secondary Schools Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of students} \times \frac{164\,\frac{\text{meals}}{\text{student}}}{\text{year}} \times \text{X}\,\frac{\text{lbs}}{\text{meal}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 0.35 or 0.52

2.4.4. Changes in Version 3.1

No changes were made in Version 3.1.

2.5. Hospitality Industry

As listed in **Table 9**, establishments belonging to five NAICS codes were classified as the hospitality industry.

Table 9. NAICS Codes for the Hospitality Industry

No.	NAICS Code	NAICS Code Description
1	713210	Casinos (except Casino Hotels)
2	721110	Hotels and Motels
3	721120	Casino Hotels
4	721191	Bed-and-Breakfast Inns
5	721199	All other Traveler Accommodation

The literature search identified 25 studies on excess food generation in the hospitality industry. EPA chose four studies that provide excess food generation factors based on empirical data

[9] 164 meals/student/year is FY19 data from USDA: National School Lunch - Participation and Meals Served. https://www.fns.usda.gov/pd/child-nutrition-tables

collected directly from sampled hotels (**Table 10**).[10] These four studies were used to estimate excess food generated, resulting in a range of values for each establishment.

Table 10. Generation Factors for the Hospitality Industry

SOURCE	YEAR	GENERATION FACTOR	UNIT
CCG	2006	1,983	lbs/employee/year
Okazaki et. al.	2008	375	lbs/employee/year
CCG	2015	1,197	lbs/employee/year
Tetra Tech	2015	997	lbs/employee/year

Most of the relevant studies reported pounds of excess food generated per hotel employee per year. A hotel excess food study from Hawaii (Okazaki et. al. (2008)) estimated excess food generated per hotel food service employee, unlike the other studies that consider excess food generated per general hotel employee. To apply data from Okazaki et al. (2008), the analysis divides the total amount of excess food generated in Hawaii hotels (as estimated by Okazaki et al. (2008)) by the total number of hotel employees under NAICS 7211 in Hawaii, to make the generation factor consistent with the other studies. These four generation factors range from 375 to 1,983 pounds per employee per year. The studies were published between 2006 and 2015 using data from three states (California, Hawaii, and New Jersey) and Vancouver, Canada.

These generation factors were used in conjunction with employee data obtained from DnB using the following equation:

$$\text{Hospitality Industry Excess Food}\left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of employees} \times \frac{\text{X } \frac{\text{lb}}{\text{employee}}}{\text{year}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 375, 997, 1197, or 1983

2.5.1. Changes in Version 3.1

No changes were made in Version 3.1.

[10] Several studies report excess food generated per meal, or per guest or guest room. EPA excluded such studies from EPA's calculations due to the lack of data on annual number of hotel guests or occupied guest rooms per year in each establishment (RecyclingWorks Massachusetts (2013); Carvalho (2014); Coker (2009)).

2.6. Correctional Facilities

To estimate the amount of excess food generated by correctional facilities, facility-level data for NAICS code 922140 was collected from DHS.

The literature search identified 27 studies on excess food generation in correctional facilities. EPA chose six studies that provide excess food generation factors based on empirical data collected from various prisons (**Table 11**).[11] These six studies were used to estimate excess food generated, resulting in a range of values for each facility.

Table 11. Generation Factors for Correctional Facilities

GENERATION FACTOR #	STUDY	YEAR	GENERATION FACTOR	UNITS
1	Marion, J.	2000	1.00	lbs/inmate/ day
2	Draper/Lennon	2001	1.00	lbs/inmate/ day
3	Kessler Consulting	2004	1.20	lbs/inmate/ day
4	Mendrey, K.	2013	1.25	lbs/inmate/ day
5	Goldstein, N.	2015	1.40	lbs/inmate/ day
6	CalRecycle	2018	0.85	lbs/inmate/ day

Two of these studies (Marion (2000) and Draper/Lennon (2001)) rely on data collected by the New York State Department of Correctional Services (NYS DOCS) Food Discard Recovery Program between 1990 and 1997. Using data collected by the NYS DOCS program, Marion (2000) found that approximately one pound per day of food scraps was recoverable per inmate.[12] Draper/Lennon (2001) used Marion's findings, but also collected data from a prison food waste composting program in Connecticut; they also found that, on average, one prisoner generates one pound of excess food per day. Additionally, nine other sources published between 2002 and 2016 rely on the Marion (2000) one pound per inmate per day estimate in calculating excess food generated in correctional facilities in various states including New Jersey and South Carolina (Mercer (2013); SCDOC (2015)).

These six excess food generation factors range from 0.85 to 1.4 pounds per inmate per day, from studies that conducted original research and collected data from correctional facilities. Capacity

[11] Several studies report the role that excess food plays in the overall prison solid waste stream. In general, these studies find that excess food makes up about 30 percent of all waste generated (Marion (2000); Kessler Consulting (2004); RecyclingWorks Massachusetts (2013); Hodge et al (2016); CalRecycle (2018)).

[12] Marion's language is ambiguous as to whether the one pound/inmate/day estimate is the total excess food generated or the amount of excess food recovered. The analysis assumes that the recoverable portion of excess food is equivalent to excess food generation in correctional facilities.

numbers were found for facilities through DHS, and that number was used as a proxy for number of inmates. In instances where the study provided a range in the amount of excess food generated per inmate per day, EPA used the midpoint of the range. These studies were published between 2000 and 2018 using data from six states.[13] While the Marion (2000) and Draper/Lennon (2001) studies are older, they are frequently cited in other studies (see BSR (2012); RecyclingWorks Massachusetts (2013); Labuzetta et al. (2016)); therefore, EPA retained them in this analysis.

DnB does not provide data on the number of inmates at each correctional facility, but it does provide the number of employees at each facility. In order to use generation factors that are based on pounds per inmate, EPA estimated the average number of inmates per employee. The Bureau of Justice Statistics (BJS (2016), BJS (2005a), BJS (2005b)) publishes information on the number of inmates and employees for county and city jails and for state and federal prisons:

- County and city jails: 3.1 inmates/employee[14]
- State and federal prisons: 3.4 inmates/employee[15]

Using these data, the following equation was used to generate estimates of excess food for correctional facilities:

$$\text{Correctional Facilities Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Capacity (\# of inmates)} \times \frac{X \frac{\text{lb}}{\text{inmate}}}{\text{day}} \times 365 \frac{\text{days}}{\text{year}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 0.85 to 1.4

2.6.1. Changes in Version 3.1

No changes were made in Version 3.1.

2.7. Healthcare Facilities

2.7.1. Hospitals

As listed in **Table 12**, establishments belonging to three NAICS codes were grouped as hospitals. Establishment-level data for this sector was obtained from the Department of Homeland Security (DHS (2020)).

[13] California, Connecticut, Florida, New York, Pennsylvania, and Washington.

[14] In 2016, 704,500 inmates were confined in city and county jails (BJS (2016), Table 7) and there were 226,300 total employees (BJS (2016), Table 8). 704,500 inmates/226,300 total employees = 3.1 inmates per employee in city and county jails.

[15] The total number of prisoners under the jurisdiction of Federal and State adult correctional authorities was 1,525,924 at year end 2005 (BJS (2005b), page 1). The total number of employees in correctional facilities under Federal and State authority at year end 2005 was 445,055 (BJS (2005a), Table 4). 1,525,924 prisoners/445,055 total employees = 3.4 prisoners per employee in federal or state prisons.

Table 12. NAICS Codes for Hospitals

No.	NAICS Code	NAICS Code Description
1	622110	General Medical and Surgical Hospitals
2	622210	Psychiatric and Substance Abuse Hospitals
3	622310	Specialty (except Psychiatric and Substance Abuse) Hospitals

The literature search identified a total of 46 studies addressing excess food generation in hospital settings. Many of these studies, however, are not directly useful to methods development. Some lack quantitative information on generation factors, while others apply generation factors from earlier studies. EPA chose four studies that either involved original research (e.g., sorting/analysis of hospital waste) or which present foundation estimates widely cited in the literature. These four studies were used to estimate excess food generated, resulting in a range of values for each facility (**Table 13**).

Table 13. Generation Factors for Hospitals

SOURCE	YEAR	GENERATION FACTOR	UNITS
Draper/Lennon	2001	1,248.3	lbs/bed/year
NCDENR	2012	468.2	lbs/bed/year
Walsh	1993	663.4	lbs/bed/year
CCG	2015	232.6	lbs/bed/year

The highest generation factor is from Draper/Lennon (2001) which is widely cited in other studies estimating excess food (see RecyclingWorks Massachusetts (2013); NRDC (2017); BSR (2012); among others). While widely applied, the generation factors in Draper/Lennon (2001) are built on original research developed in the 1990s, hence EPA supplemented this data point with other studies. Both the NCDENR (2012) study and the CCG (2015) study are more recent and use original waste sampling. The Walsh (1993) study is older but provides an additional data point for corroboration of the generation per bed figures.[16]

These four generation factors were used in conjunction with hospital bed data obtained from DHS to estimate a range of generation rates for the three NAICS codes identified as hospitals. This is reflected in the following equation:

[16] The analysis of hospitals in the NCDENR report draws on a study of Orange County, North Carolina. The only hospital in the county is the University of North Carolina Medical Center, which has 803 beds (see https://www.uncmedicalcenter.org/uncmc/about/). EPA's analysis uses that figure to calculate pounds of excess food per bed. Both the CCG (2015) and Walsh (1993) studies report total solid waste generation per hospital bed. CCG (2015) provides a detailed composition analysis indicating that 20.4 percent of the hospital solid waste is food, allowing calculation of excess food per bed. EPA's analysis applies the same composition assumption (20.4 percent) to the Walsh (1993) solid waste per bed figure to estimate excess food per bed.

$$\text{Hospitals Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{\# of Beds} \times \frac{\text{X } \frac{\text{lb}}{\text{bed}}}{\text{year}} \times \frac{\text{tons}}{2{,}000 \text{ lb}}$$

Where X = 232.6, 468.2, 663.4, or 1248.3

2.7.2 Nursing Homes

As listed in **Table 14**, establishments belonging to six NAICS codes were grouped as nursing homes. Establishment-level data for this sector was obtained from both the Department of Homeland Security (DHS (2020)) and DnB.

Table 14. NAICS Codes for Nursing Homes

	NAICS Code	NAICS Code Description
1	623110	Nursing Care Facilities
2	623210	Residential, Intellectual and Developmental Disability Facilities
3	623220	Residential Mental Health and Substance Abuse Facilities
4	623311	Continuing Care Retirement Communities
5	623312	Assisted Living Facilities for the Elderly
6	623990	Other Residential Care Facilities

Nursing homes were mapped without excess food estimates.

2.7.3 Changes in Version 3.1

No changes were made in Version 3.1.

2.8. Restaurants and Food Services

Six industries were classified as restaurants and food services (**Table 15**). Establishment-level data for this sector was obtained from DnB.

Table 15: NAICS Codes for Restaurants and Food Services

No.	NAICS Code	NAICS Code Description
1	722320	Caterers
2	722330	Mobile Food Services
3	722511	Full-Service Restaurants
4	722513	Limited-Service Restaurants
5	722514	Cafeterias, Grill Buffets, and Buffets
6	722515	Snack and Nonalcoholic Beverage Bars

Industries were classified as full-service or limited-service according to their six-digit NAICS codes. Full-service establishments include Caterers (NAICS code 722320), Full-Service Restaurants (NAICS codes 722511) and Cafeterias, Grill Buffets, and Buffets (NAICS code 722514). Limited-service establishments include Mobile Food Services (NAICS code 722330), Limited-service Restaurants (NAICS codes 722513), and Snack and Nonalcoholic Beverage Bars (NAICS code 722515).

The literature search identified a total of 49 studies that address excess food generation in restaurant and food service settings. Many of these studies, however, do not provide directly useful generation data. Some lack quantitative information on generation factors, while others apply generation factors derived from earlier studies. EPA chose five studies that either involved original research (e.g., sorting/analysis of facility waste) or which present generation factors that are widely cited in the broader literature (**Table 16**). These five studies were used to estimate excess food generated, resulting in a range of values for each establishment.

Table 16. Generation Factors for Restaurants and Food Services

GENERATION FACTOR #	SOURCE	YEAR	GENERATION FACTOR	UNITS	ESTABLISHMENT TYPE
1	CCG	2006	3,392 for full-service	lbs/employee/year	Full-service and limited service estimated separately
2			2,494 for limited service		
3	Draper/ Lennon	2002	3,000	lbs/employee/year	Unspecified
4	CCG	2015	2,760	lbs/employee/year	Full-service and limited service estimated together
5	BSR	2014	0.033	lbs/revenue/year	Unspecified

The three studies used to establish generation factors 1-4 established factors based on pounds per employee per year. The Draper/Lennon (2002) study, developed for the Massachusetts Department of Environmental Protection and updated by EPA Region 1 in 2011, was widely cited (see RecyclingWorks Massachusetts (2013); Mercer (2013); SCDOC (2015); among others). While widely applied, the generation factors in Draper/Lennon (2002) are built on original research developed in the 1990s. Both the CCG (2006) and CCG (2015) studies are more recent and use waste sampling techniques to estimate of excess food generation.

BSR (2014) collected industry generation data through a series of surveys and estimated 33 pounds of excess food generated per thousand dollars of company revenue.

factors 2, 3, 4, and 5 were used to estimate excess food generation rates for the establishments in the three NAICS codes classified as limited-service establishments.

Generation factors 1-4 use the following equation:

$$\text{Restaurants and Food Services Sector Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Number of employees} \times \frac{\text{X}\,\frac{\text{lb}}{\text{employee}}}{\text{year}} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

Where X = 2494 to 3,392

Generation factor 5 uses the following equation:

$$\text{Restaurants and Food Services Sector Excess Food } \left(\frac{\text{tons}}{\text{year}}\right) =$$

$$\text{Establishment's Annual Revenue } \$ \times 0.033 \frac{\text{lb}}{\text{Annual Revenue } (\$)} \times \frac{\text{tons}}{2{,}000\ \text{lb}}$$

2.8.1. Changes in Version 3.1

No changes were made in Version 3.1.

2.9. Food Banks, Food Pantries and Soup Kitchens

Food banks, food pantries and soup kitchens are considered potential generators as well as potential recipients of excess food. This is because some of the food they receive as donations may be expired, degrading, or otherwise deemed unfit for human consumption, or not in line with the needs of the community being served. In 2015, food bank data was provided by Feeding America, a nationwide network of food banks, food pantries, and meal programs. Specifically, Feeding America provided data on generation of excess food as reported by individual food banks in its network, where available. For Version 3.1 of the map, data was provided by Hunger Free America, which maintains a database of food banks, food pantries, soup kitchens and related programs and administrative offices, with funding from the USDA to manage the National Hunger Clearinghouse. Hunger Free America provided data on establishment type (food bank, food pantry, or soup kitchen), name, address, website, and whether food donations are accepted (if information was available). Data on a few Feeding America food banks were added to the Hunger Free America data. The data set does not include food generation estimates.

2.9.1. Changes in Version 3.1

A new data source – Hunger Free America – was found and its data added substantially to the total number of mapped establishments, increasing the number from around 300 to over 8,400. However, Hunger Free America's data do not include excess food generation estimates, so there are no longer excess food estimates for food banks, food pantries, or soup kitchen establishments.

2.10. Farmers Markets

Farmers markets are considered potential generators of excess food. Data for farmers markets were retrieved from the USDA Local Foods Directory (USDA (2024)), which keeps a comprehensive list of markets in the 50 states, Washington D.C., and Puerto Rico. Generation factors were not available to calculate estimates of excess food from farmers markets.

2.10.1 Changes in Version 3.1

The Farmers Market layer was updated with the data downloaded from USDA's Local Foods Directory in summer 2024, increasing the number of mapped markets from roughly 1,000 to almost 7,000.

2.11 Data Analysis

Over 960,000 establishments that potentially generate excess food were included in the dataset and map from ICI sectors based on 90 NAICS codes, three school types, farmers markets, and food banks, food pantries and soup kitchens. The dataset provides establishment-level information including name and geographic location, and source data included common business statistics such as revenue, number of employees, or number of students which was used to estimate excess food generation using sector-specific equations, as detailed in sections 2.2 to 2.10. Excess food generation rates were estimated for 89.4% of establishments. Establishments for which generation rates could not be estimated were still mapped. There were several equations available to calculate excess food estimates for most sectors, resulting in a range of values for each establishment; a high and low excess food estimate was included for each establishment in those sectors.

The data were reviewed and filtered in the following ways:

- Duplicates were defined as establishments with identical names and physical addresses. If an establishment had multiple observations, it was assigned the minimum for number of employees and revenue among all its observations.
- For data missing geographic coordinates, addresses, or other location-based information, ArcGIS was used to fill in gaps.

3. Macro Analysis of Sector-Specific Excess Food Generation Rates

The dataset provides establishment-level estimates of excess food in each identified sector for which generation factors were available. Data for the 966,043 establishments were obtained primarily from DnB, as well as the NCES databases, DHS, USDA, Feeding America and Hunger Free America. Excess food generation rates were estimated for 89.4% of all establishments. Estimation was not possible if either EPA does not have a generation factor(s) for that sector, or if the data needed to calculate an estimate for an establishment were missing. In either case, no excess food estimate was reflected in the dataset, though the establishment was still mapped. Estimates were not possible for farmers markets or food banks, food pantries and soup kitchens. For other sectors, estimates were not possible for 100% of establishments.

Figure 3. Non-Residential Excess Food Generating Sectors

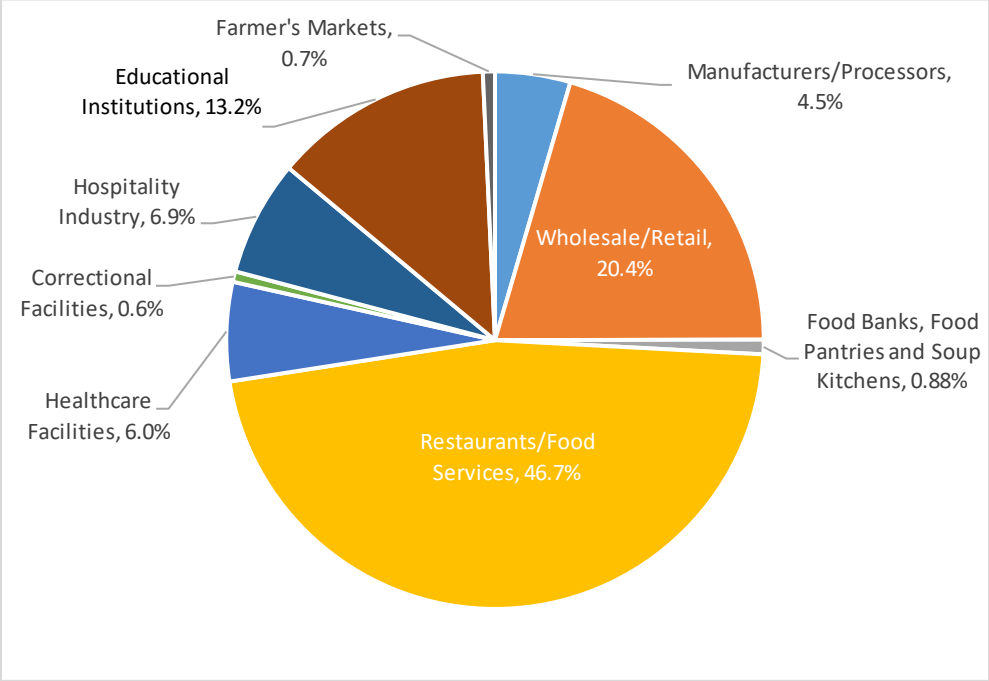


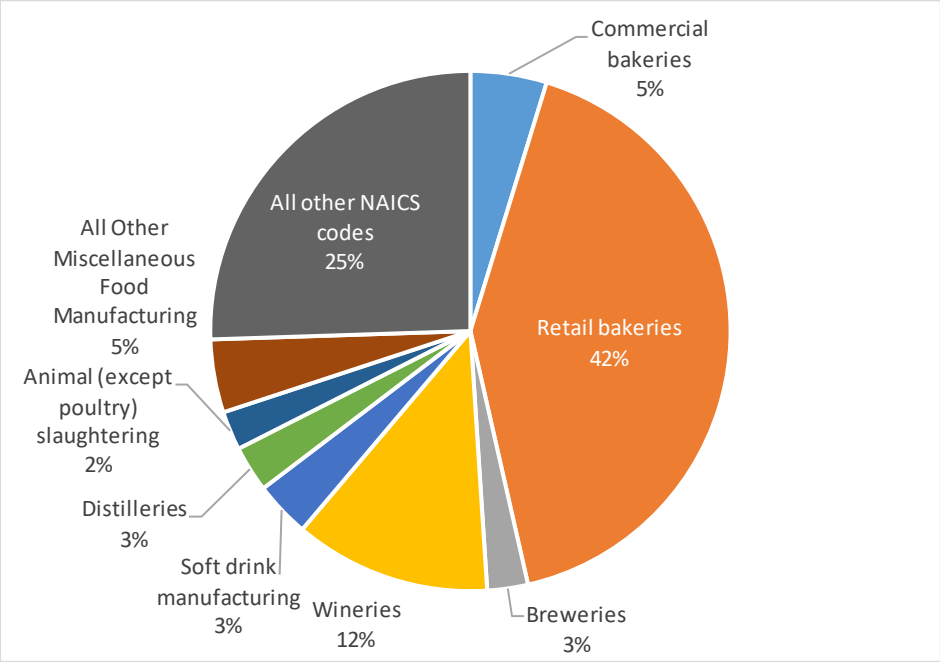
Table 17. Establishments Included in the Dataset by Sector

Sector	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Food Manufacturers & Processors	43,738	39,473	90.2%
Food Wholesale & Retail	197,455	194,609	98.6%
Educational Institutions	127,547	123,719	97.0%
Hospitality Industry	67,116	47,143	70.2%
Correctional Facilities	6,118	4,713	77.0%
Healthcare Facilities	57,521	7,033	12.2%
Restaurants and Food Services	451,092	447,233	99.1%
Food Banks	8,460	0	0%
Farmers Markets	6,996	0	0%
Total	966,043	863,923	89.4%

3.1. Food Manufacturers and Processors

The food manufacturers and processors sector, as described in Section 2.2, includes 45 NAICS codes. Data were obtained for 43,738 establishments, and excess food estimates were generated for 90.2% of the establishments. **Figure 4** shows the proportion of food manufacturers and processors by industry type[17]. **Table 18** shows more granular information about data availability across the sector.

Figure 4. Proportion of Food Manufacturers and Processors by Industry Type



[17] NAICS codes with at least 1000 associated establishments in the dataset are highlighted in the chart and table below. The segment "All Other NAICS Codes" includes the 37 codes with fewer than 1000 associated establishments in the dataset.

Table 18. Number of Food Manufacturers and Processors Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
All Other Miscellaneous Food Manufacturing	1,988	1,766	88.8%
Animal (except poultry) slaughtering	1,056	906	85.8%
Breweries	1,105	1,039	96.5%
Commercial bakeries	2,074	1,814	87.5%
Distilleries	1,253	1,175	93.8%
Retail bakeries	18,238	17,406	95.4%
Soft drink manufacturing	1,518	1,029	67.8%
Wineries	5,347	5,077	95.0%
All other NAICS codes	11,159	9,261	83.0%
Total	43,738	39,473	90.2%

3.2. Food Wholesale and Retail

The food wholesale and retail sector, as described in Section 2.3, encompasses 24 NAICS codes. Data were obtained for 197,455 establishments associated with these codes, and excess food estimates were generated for 98.6% of establishments.

Figure 5 shows the proportion of food wholesalers and retailers by industry type; 82% of which are food retailers (supermarkets, grocery stores, and supercenters) and 18% are food wholesalers. **Table 19** shows more granular information about data availability across the sector.

Figure 5. Proportion of Food Wholesale and Retail Establishments by Industry Type

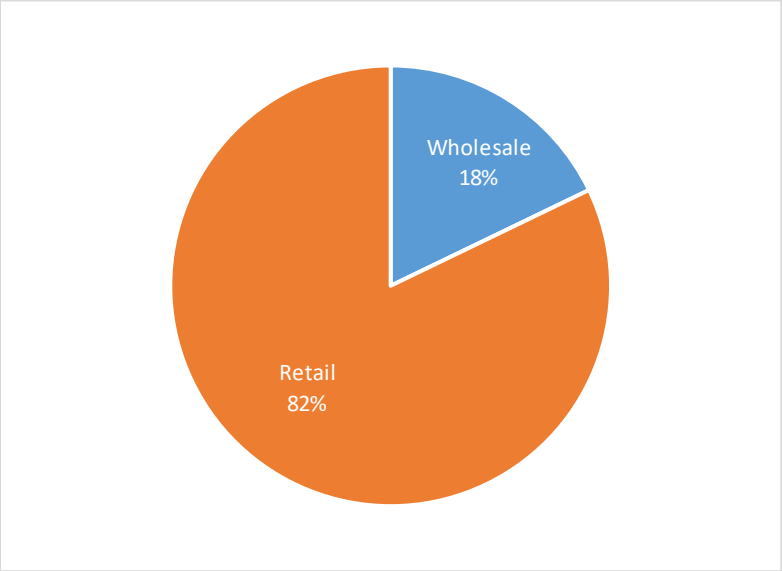


Table 19. Number of Food Wholesale and Retail Establishments Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Food Wholesalers	35,226	32,446	92.1%
Food Retailers (Supermarkets, Grocery Stores, and Supercenters)	162,229	162,163	99.96%
Total	197,455	194,609	98.6%

3.3. Educational Institutions

The educational institutions sector, as described in Section 2.4, encompasses three school types. These are postsecondary schools, public elementary and secondary schools, and private elementary and secondary schools. **Figure 6** shows the proportion of educational institutions by type, and **Table 20** shows more granular information about data availability across the sector.

Figure 6. Proportion of Educational Institutions by School Type

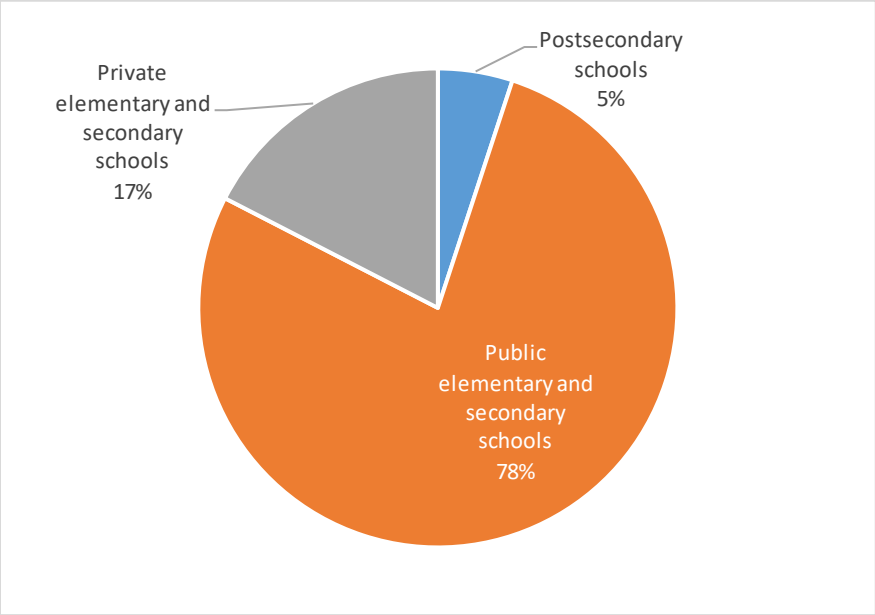


Table 20. Number of Educational Institutions Included in the Dataset

School Type	Institutions in the Dataset	Institutions with Excess Food Estimate	% Institutions with Excess Food Estimate
Postsecondary Schools	6,435	6,170	95.9%
Public Elementary and Secondary Schools	98,882	22,109	99.5%
Private Elementary and Secondary Schools	22,230	95,440	96.5%
Total	127,547	123,719	97.0%

3.4. Hospitality Industry

The hospitality industry, as described in Section 2.5, encompasses five NAICS codes. Data were obtained for 67,116 establishments associated with these codes, and excess food estimates were generated for 70.2% of the sample.

Figure 7 shows the proportion of hospitality establishments by industry type, and **Table 21** shows more granular information about data availability across the sector.

Figure 7. Proportion of Hospitality Industry Establishments by Type

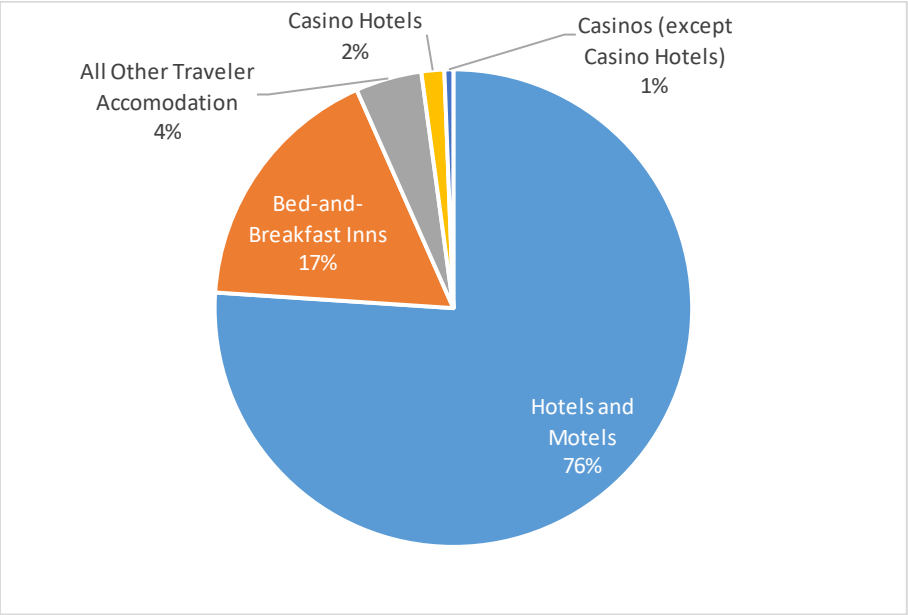


Table 21: Number of Hospitality Establishments Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Hotels and Motels	51,038	35,918	70.4%
Casino Hotels	1,037	752	72.5%
Casinos (except Casino Hotels)	407	291	71.5%
Bed-and-Breakfast Inns	11,623	8,087	69.6%
All Other Traveler Accommodation	3,011	2,095	69.6%
Total	67,116	47,143	70.2%

3.5. Correctional Facilities

The correctional facilities sector, as described in Section 2.6, encompasses one NAICS code. Data were obtained for 6,118 facilities associated with this code, and excess food estimates were generated for 77.0% of the sample.

3.6. Healthcare Facilities

The healthcare facilities sector, as described in Section 2.7, encompasses three NAICS codes for hospitals and six NAICS codes for nursing homes. Data were obtained for 7,275 hospitals and

50,246 nursing homes, and excess food estimates were generated for 12.2% of the sample. Estimates were not generated for any nursing homes or residential care facilities, only for hospitals.

Figure 8 shows the proportion of healthcare facilities by industry type, and **Table 22** shows more granular information about data availability across the sector.

Figure 8. Proportion of Healthcare Facilities by Industry Type

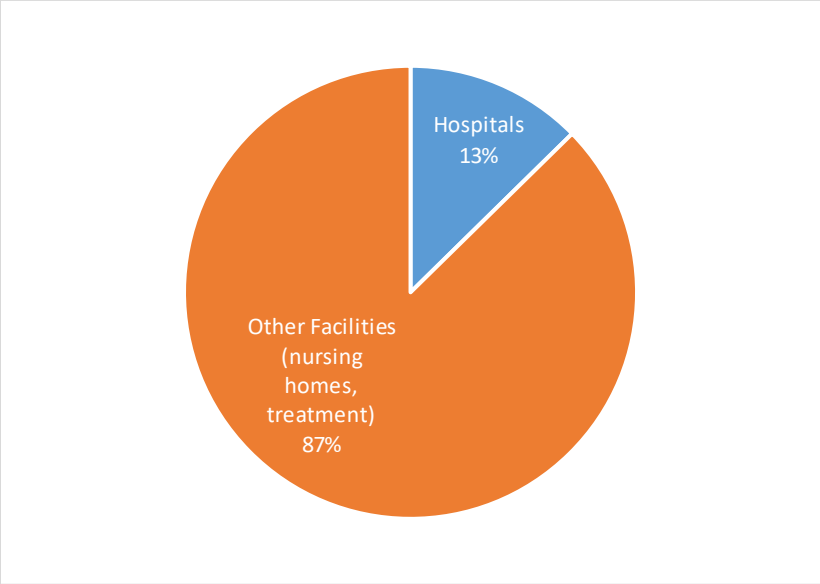


Table 22: Number of Healthcare Facilities Included in the Dataset

Industry	Facilities in the Dataset	Facilities with Excess Food Estimate	% Facilities with Excess Food Estimate
General Medical and Surgical Hospitals	5,794	5,608	96.8%
Psychiatric and Substance Abuse Hospitals	646	616	95.4%
Specialty (except Psychiatric and Substance Abuse) Hospitals	835	809	96.9%
Assisted Living Facilities for the Elderly	23,358	0	0%
Nursing Care Facilities	15,694	0	0%
Other Residential Care Facilities	8,201	0	0%
Residential, Intellectual, and Developmental Disability Facilities	658	0	0%
Residential Mental Health and Substance Abuse Facilities	2,247	0	0%
Continuing Care Retirement Communities	88	0	0%
Total	57,521	7,033	12.2%

3.7. Restaurants and Food Services

The restaurants and food services sector, as described in Section 2.8, encompasses six NAICS codes. Data were obtained for 451,092 establishments associated with these NAICS codes, and excess food estimates were generated for 99.1% of the sample.

Figure 9 shows the proportion of restaurants and food services establishments by industry type and **Table 23** shows more granular information about data availability across the sector.

Figure 9. Proportion of Restaurant and Food Services Establishments by Industry Type

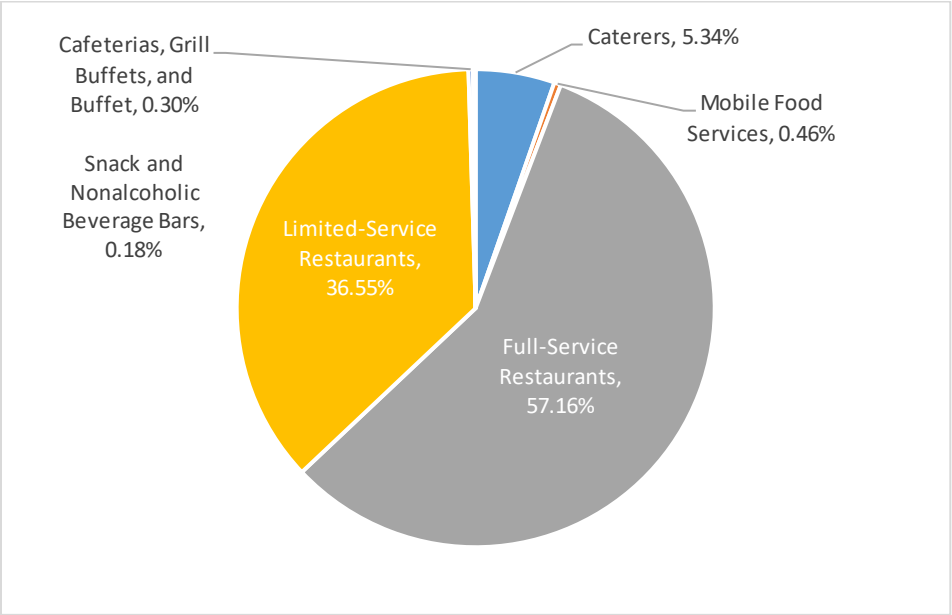


Table 23: Number of Restaurants and Food Services Establishments Included in the Dataset

Industry	Establishments in the Dataset	Establishments with Excess Food Estimate	% Establishments with Excess Food Estimate
Caterers	24,103	23,868	99.0%
Mobile Food Services	2,074	2,073	99.99%
Full-Service Restaurants	257,857	255,562	99.1%
Limited-Service Restaurants	164,887	163,591	99.2%
Cafeterias, Grill Buffets, and Buffets	1,358	1,344	99.0%
Snack and Nonalcoholic Beverage Bars	813	795	97.8%
Total	451,092	447,233	99.1%

3.8. Food Banks, Food Pantries and Soup Kitchens

Food banks, food pantries and soup kitchens, as described in Section 2.9, encompass 8,460 establishments, for which no excess food estimates were generated.

3.9. Farmers Markets

Farmers markets, as described in Section 2.10, encompass 6,996 markets, for which no food waste estimates were generated.

4. Data Sources for Recipients

4.1. Overview

The map displays facility-specific information for four categories of potential recipients of excess food, the data sources for which are described below.

4.2. Food Banks, Food Pantries and Soup Kitchens

Food banks, food pantries and soup kitchens are considered potential recipients (because they receive donated food that often would otherwise have gone to landfill, composting, etc.) as well as generators of excess food (because some of the food they receive as donations may be deemed unfit for human consumption and cannot be given to humans). In 2015, food bank data were provided by Feeding America, a nationwide network of food banks, food pantries, and meal programs. In Version 3.1, a larger dataset provided by Hunger Free America substantially increased the total number of food banks, food pantries and soup kitchens in the dataset. Data on a few Feeding America food banks were added to the Hunger Free America data for a total of 8,460 establishments.

4.3. Composting Facilities

Data for composting facilities were primarily compiled through EPA review of state government websites, usually state departments of natural resources or environmental protection, and communication with state government employees. Additional data were gleaned through web searches, public data from towns, cities, composting non-profits and associations, and communications with EPA Regional offices. Version 3.0 of the map contained 3,877 composting facilities in 50 states and two territories. In Version 3.1, facilities were added from EPA's Disaster Debris Recovery Tool (2024b), which also maintains a dataset of composting and mulching facilities in the US. The two datasets were combined in order to maintain a single, consistent EPA dataset of composting and mulching facilities in the US. Version 3.1 of the map contains 4,669 composting facilities. Associated websites and types of feedstock accepted are listed in the dataset and in the map, where information was available. This dataset includes composting facilities that accept all types of feedstocks, not just food waste. With the addition of facilities from the DDRT, this dataset also includes mulching facilities. Community composting and on-farm composting fall largely outside the scope of the map, but the dataset may contain a few composting sites that could be categorized as such. Food scrap drop-off sites are also out of scope. Facilities that are known to accept food waste are identified in the map and dataset; not all accepted feedstocks,

facility locations, or contact information were verified by EPA. Specific sources for composting facility information are included in the dataset.

4.4. Anaerobic Digestion Facilities

EPA updated the anaerobic digestion (AD) facilities dataset in Version 3.1 of the map, resulting in a dataset containing 1,850 facilities. The updated Version 3.1 dataset was compiled from (1) a list of facilities on farms maintained by AgSTAR (US EPA (2024c)); (2) a list of stand-alone food waste digesters compiled by the American Biogas Council (2024); (3) a list of stand-alone food waste digesters, on-farm digesters that co-digest food waste, and digesters that co-digest food waste at water resource recovery facilities (WRRFs) who responded to EPA's AD Data Collection Survey in 2021 (US EPA (2023d)); and (4) the list of AD facilities at WRRFs maintained by the Water Environment Federation (WEF (2019)). Additional facilities were identified through web searches, public data from non-profits and trade associations, and state government websites. Where available, data are included on types of feedstock (e.g., types of food waste, animal manures) accepted by the facility. This dataset includes anaerobic digestion facilities that accept all types of feedstock, not just food waste. Facilities that are known to accept food waste are identified in the map and dataset.

5. Infrastructure to Support Excess Food Management

5.1. Communities with Residential Source Separated Organics Programs

In Version 3.0 of the map, 275 communities with residential curbside food waste collection were identified from a 2021 survey by BioCycle (Goldstein (2021), following the 2017 survey by Platt and Streeter, published in BioCycle) supplemented with data from state government websites and public data from select composting non-profits and associations. No changes were made in Version 3.1. Specific sources for data are identified in the dataset. All 275 communities were mapped. Some communities are counties or solid waste districts that have programs that serve multiple cities or areas, while some communities are single towns or cities with their own programs. Not all programs serve all households within the specified community, and EPA was often unable to identify the number of households within a community with access to a curbside program. As such, the total number of households with access in this dataset is not an accurate representation of national access to curbside food waste collection. This dataset includes communities with municipally supported residential source separated organics programs that collect food scraps and does not include those communities that only collect yard waste.

5.2. Refrigerated Warehousing and Storage

Refrigerated warehousing and storage facilities were mapped for the first time in Version 3.0. No changes were made in Version 3.1. One industry was classified in this sector (**Table 24**). Establishment-level data for this sector was obtained from DnB.

Table 24. NAICS Codes for Refrigerated Warehousing and Storage

No.	NAICS Code	NAICS Code Description
1	493120	Refrigerated Warehousing and Storage

There are roughly 585 establishments listed with geographic location and website where available.

6. USDA Food Assistance and Food Insecurity Data Layers

Food assistance and food insecurity data layers were first added in Version 3.0 of the map. In Version 3.1., changes were made to which data layers are included in the map. Food insecurity and access – including proximity to establishments that sell food – are critical metrics of a healthy food system. Participation rates in programs such as the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and the National School Lunch Program (NSLP) reflect areas where income is lower, and food assistance is crucial to community and economic wellbeing. Users can overlay food access data with excess food or recipients. This type of visualization can drive policy, infrastructure and investment decisions, and spur action to improve outcomes in a community.

6.1. USDA Food Environment Atlas

Version 3.1 of the map features Food Assistance and State Food Insecurity layers from the USDA's Food Environment Atlas (ERS (n.d.b)). The Food Assistance layer includes these sublayers: SNAP, WIC, FDPIR, National School Lunch Program, School Breakfast Program, Summer Food Service Program, and Child & Adult Care. More information, including data sources and definitions, is available on the Food Environment Atlas webpages (ERS (n.d.b)).

6.2. USDA Food Access Research Atlas

Version 3.1. of the map pulls in low income and food access data layers from the USDA's Food Access Research Atlas. Featured layers include Low Income, Low Access at 1 and 10 miles, Low Access at ½ and 10 miles, Low Access at 1 and 20 miles, and Low Vehicle Access, as well as combined Low Income & Low Access layers. More information, including data sources and definitions, is available on the Food Access Research Atlas webpages (ERS (n.d.a.)).

7. Limitations and Opportunities for Improvement

This section summarizes limitations associated with the methodology as well as recommendations for future improvements.

Map and methodology limitations and opportunities for improvement include the following:

1. **Generation factors**. Generation factors in the methodologies adopted for this study are based on limited measured data. Although the methodologies adopted for the map provide a simple approach to estimate excess food generation from an ICI establishment, on-site

measurement is always preferred. Farmers markets, food banks, food pantries and soup kitchens, and some establishments from other sectors did not have generation factors. Additionally, generation factors rely on certain metrics – for instance, number of beds in nursing homes – which are not available for all establishments.

2. **Recoverable fraction of excess food**. The recoverable fraction of excess food could be used to feed people, which represents the most preferred use of excess food. A reliable estimate of the recoverable fraction of excess food is critical data needed to pursue its best use. If methodologies become available to estimate the recoverable fraction of excess food available by sector, EPA could include these estimates in a future version of the map.

3. **On-farm loss.** This methodology and map do not address on-farm loss, including unharvested crops or unmarketable crops. ReFED estimates that farming generated 17.6M tons of surplus produce in 2023, of which most is left unharvested in the field (ReFED (2024)).

4. **Food rescue organizations.** Version 3.1. includes more food banks, food pantries and soup kitchens than previous versions of the map. However, there are many more organizations that rescue food or accept donations and distribute food to people in need. This is a dynamic sector for which finding and maintaining accurate data remains a challenge.

5. **Communities with source separated organics programs.** The data for this layer are limited, and the total number of communities in the dataset is likely an undercount.

6. **Community composting sites.** The dataset of composting facilities does not generally include community composting sites, on-farm composting sites, or other small-scale, local composting operations that process excess food and other organic material from the surrounding community. This is a growing sector in composting and should be included in future map updates.

7. **Anaerobic digestion at water resource recovery facilities.** The data on anaerobic digestion facilities is most up to date for on-farm and stand-alone AD facilities. The data on WRRFs with AD should be updated in a future version of the map.

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Appendix A: Glossary

The definitions below are specifically tailored to the scope and aims of this paper.

AgSTAR: An EPA effort that promotes the use of biogas recovery systems to reduce methane emissions from livestock waste. AgSTAR assists those who enable, purchase, or implement anaerobic digesters by identifying project benefits, risks, options, and opportunities. AgSTAR also provides the Livestock Anaerobic Digester Database that offers basic information about anaerobic digesters on livestock farms in the United States.

ANAEROBIC DIGESTION: The biochemical decomposition of organic matter into methane gas and carbon dioxide by microorganisms in the absence of oxygen.

ANTHROPOGENIC METHANE EMISSIONS: Methane (CH4), a potent greenhouse gas, emitted due to human activities.

COMPOST: An organic (derived from living matter) material that can be added to soil to help plants grow and enhance soil health by building organic matter in the soil, providing essential plant nutrients, retaining moisture, suppressing plant diseases and pests, and encouraging a proliferation and diversity of beneficial microbes.

COMPOSTING: Breaking down material via bacteria in oxygen-rich environments. Composting refers to the production of organic material (via aerobic processes) that can be used as a soil amendment. (Food Loss and Waste Protocol, 2016)

EXCESS FOOD: For purposes of this project, the phrase "excess food" generally refers to food—whether processed, semi-processed, or raw—that was not used for its intended purpose and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or sending to landfills or incinerators. Examples include unsold food from retail stores; plate waste, uneaten prepared food, or kitchen trimmings from restaurants, cafeterias, and households; or by-products from food and beverage processing facilities. EPA also often refers to this as "wasted food."

The studies that EPA relies on in this methodology do not distinguish between food and inedible parts (e.g., pits, rinds, bones) (such as those discarded in restaurant kitchens or during processing), so inedible parts are included in EPA's estimates. Furthermore, the residential and agricultural sectors, which can also generate excess food, were excluded from the map.

"Wasted food," "food waste," "surplus food," or "excess food" are terms commonly used to describe food that was not used for its intended purpose.

EXCESS FOOD GENERATION FACTORS: The values used to estimate excess food generation rates. Sector-specific surveys and/or literature-reported values were used to extract theses values which are consistent across a sector for each establishment. Examples of excess food generation factors are amount of excess food per employee per year, or amount of excess food per student per year.

FEEDSTOCK: Organic materials that are combined in specific ratios for organics recycling (e.g., composting or anaerobic digestion), such as excess food, yard trimmings, manures, or biosolids.

FOOD LOSS: Unused product from the agricultural sector, such as unharvested crops.

FOOD RECOVERY: The action of collecting excess food to feed people.

INEDIBLE PARTS: As defined by the FLW Protocol, these are components associated with a food that, in a particular food supply chain, are not intended to be consumed by humans. Examples of inedible parts associated with food could include bones, rinds, and pits/stones.

MUNICIPAL SOLID WASTE (MSW): Garbage or refuse generated by households, commercial establishments, or institutional facilities.

ORGANICS: Carbon-based materials such as excess food or yard trimmings that can be recycled, e.g., via composting or anaerobic digestion. Organics can be used as feedstock in composting (creating a rich soil amendment) and anaerobic digestion (generating biogas and producing a fertilizer substitute/soil amendment). Materials included in the definition of organics or organic waste vary by state and local jurisdiction (some may include manures, biosolids, wood, paper, and cardboard).

ORGANIC WASTE: Organic (carbon-based) materials in the waste stream, such as excess food and yard trimmings.

PLATE WASTE: Post-consumer leftover food, or food that has been served and not eaten. Also known as "front of house" excess food.

RECOVERABLE EXCESS FOOD: Food suitable for human consumption at or near the time of disposal, and suitable for donation or sale to secondary markets.