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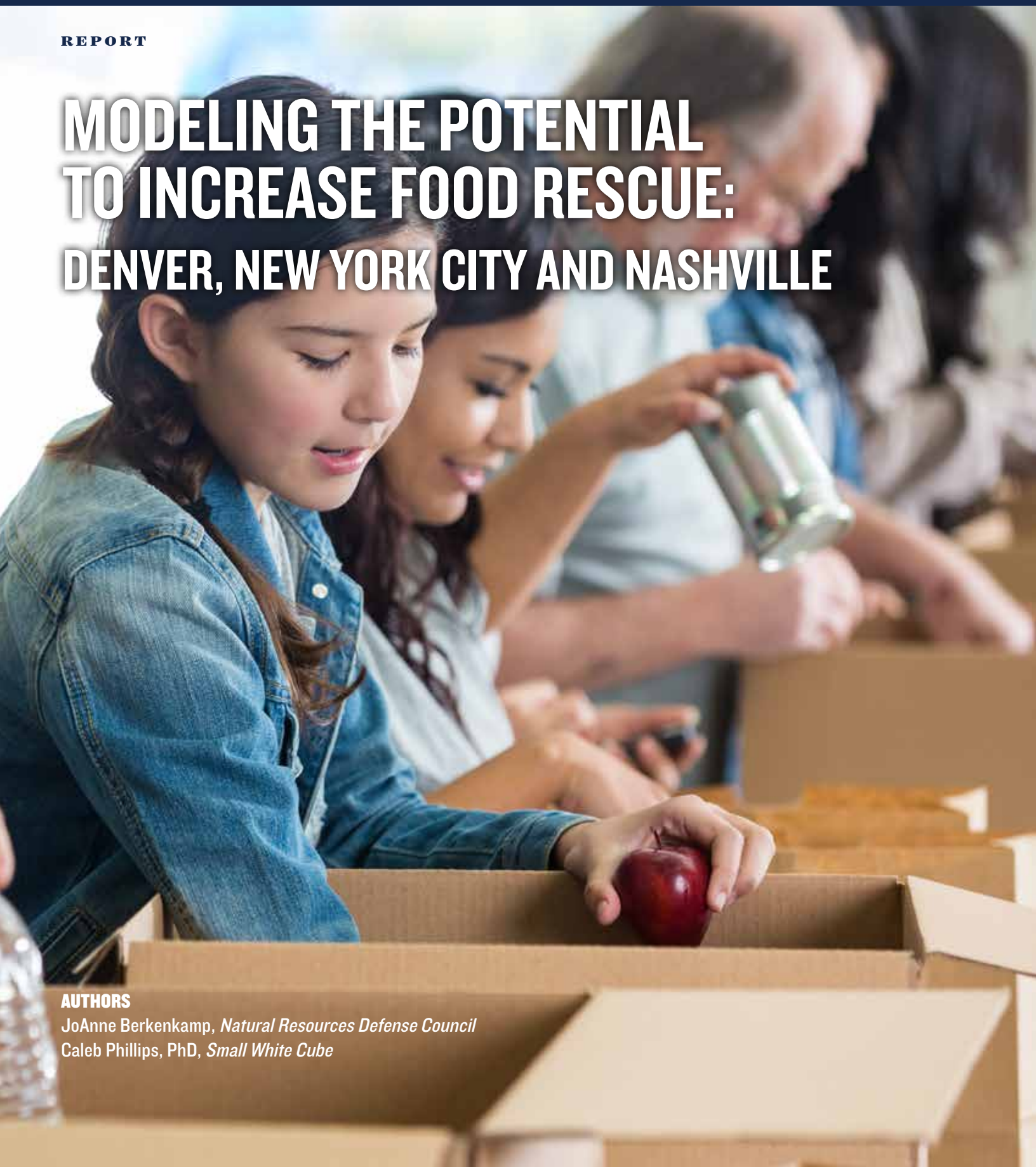
REPORT

MODELING THE POTENTIAL TO INCREASE FOOD RESCUE:

DENVER, NEW YORK CITY AND NASHVILLE



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About NRDC

The Natural Resources Defense Council is an international nonprofit environmental organization with more than 3 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Montana, and Beijing. Visit us at nrdc.org.

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Executive Summary

Photo courtesy of Aramark

There is nothing more shocking or ironic than the fact that up to 40 percent of the U.S. food supply goes uneaten each year,[1] yet more than 41 million people lack a secure supply of food to their tables.[2] Excess and scarcity rub elbows every day, leading to negative consequences for the health and social wellbeing of low income communities as well as our environment and economy.

Efforts to keep good food from going to waste through food donation are accelerating in communities across the country as food rescue organizations of all sizes increase their efficiency and scale. In tandem, many food-based businesses are becoming more aware of the feasibility and benefits of donating surplus food. Food rescue efforts that connect surplus foods with those in need play a key role in meeting near-term food insecurity needs while reducing wasted food.

Municipal governments, however, have typically lacked a mechanism to assess how much more surplus food could potentially be donated by the businesses and institutions in their community or evaluate the role that food rescue efforts can play in a broader strategy to curtail wasted food. Without a guidepost for "what's possible," development of food rescue efforts within a given municipality can occur on an incremental basis and without a shared vision among city officials, anti-hunger advocates, potential donors, the philanthropic community, low income individuals and others who are (or could become) committed to addressing food insecurity in their community.

Our research aims to quantify the scale of additional foods that could potentially be rescued from sources within each city, positioning municipalities to plan for development of their food rescue system—and reduce the amount of food being discarded—in a more fully informed and strategic way.

To be sure, food donation will not rectify the underlying causes of poverty that drive hunger such as low wage rates, unemployment and disparities in access to housing, education, healthcare and transportation. It does, however, play a vital role in meeting near-term gaps in food availability for vulnerable populations. Particularly given increasing economic turbulence and income inequality, maximizing opportunities to connect appropriate surplus foods to those in need is critical.

With support from The Rockefeller Foundation, NRDC has explored the potential to keep good food from being discarded through increased food rescue in three cites: Denver, New York City and Nashville. For instance, just how big is the as-yet untapped supply of surplus, potentially rescuable food among consumer-facing businesses located within each city? What additional investments in food rescue infrastructure would be needed for a city to more fully tap that potential? And if it did so, how far could a city go in addressing unmet food needs among its residents?

These are the questions NRDC set out to explore in our research. We developed a methodology to quantify the potential for additional food rescue within a city's boundaries and applied it to Denver, New York and Nashville. In Denver, we also identified financial investments in food rescue infrastructure and operating costs that would be needed to more fully realize the city's potential for food rescue. We explored two scenarios.

Our "maximum" scenario uses our most optimistic assumptions about the amount of surplus food that could potentially be available for donation to establish an upper-most limit of what is theoretically possible. Our "ambitious" scenario uses more realistic assumptions and existing donation patterns to describe an ambitious yet attainable growth scenario.

All told, we estimated donation potential across sectors spanning more than 30,000 retail, restaurant and institutional foodservice establishments located within the three cities. We have subtracted amounts of food currently being donated from these estimates to identify the untapped potential. We then compared that potential to estimated annual food needs among individuals estimated to be food insecure in each city, as characterized by meal gap[3] data. That enables us to assess what additional portion of the meal gap could be addressed if food donations from the local economy were increased. We conducted our "food rescue potential" analysis in parallel with NRDC's baseline assessment of food now going to waste in these three cities.[4]

Highlights of our research include the following:

- Under our maximum scenario, we estimate that the untapped potential for food rescue from the grocery retail, restaurant and institutional foodservice sectors reviewed in the three cities combined is nearly 41,000 tons annually, the equivalent of roughly 68 million meals. (These are amounts beyond the donations already being made from the sectors reviewed within the geography evaluated.) We believe this represents the upper limit of what is theoretically possible given the businesses located within the three cities.
- Denver and Nashville could theoretically meet an additional 46 percent to 48 percent of their cities' meal gap under our maximum scenario, suggesting that area businesses could play a substantially larger role in addressing food insecurity than is currently the case.
- We estimate that New York City could, theoretically, meet an additional 23 percent of its meal gap under our maximum scenario.

We estimate that the theoretical untapped potential for food rescue from the grocery retail, restaurant and institutional foodservice sectors reviewed in the three cities combined is nearly 41,000 tons annually, the equivalent of roughly 68 million meals, under optimal conditions.

- Under the ambitious scenario, we found the potential for nearly 24 million more meals to be donated. This would enable the three cities to meet an additional 8 percent to 18 percent of their respective meal gaps, through increased donations from consumer-facing businesses located within their cities, beyond current food donations.
- Across all three cities, grocery retail showed the greatest untapped potential among the sectors we explored (even after current donations have been deducted). For instance, it represents just over 60 percent of the untapped potential we see under our ambitious scenario. While donation programs in the grocery sector are well-established, we found significant potential for additional donation, primarily of perishable foods such as fruits and vegetables, meat, dairy and deli items.
- The institutional food service sectors we reviewed—hospitality, healthcare, universities and K-12 schools—also have the potential to provide significant volumes of quality food. Indeed, about 26 percent of the untapped potential under the ambitious scenario across the three cities combined lies with these institutional sectors. Our analysis of estimated food surpluses suggests that hospitality (e.g. hotels) and healthcare offer the strongest potential among the institutional sectors we reviewed. Institutions have the appeal of a relatively small number of locations and potential for significant food volumes, making them a priority.

EXPANDED FOOD RESCUE COULD MEET AN ADDITIONAL 46 PERCENT OF DENVER'S MEAL GAP

- Restaurants make up about 7 percent of the untapped potential we see under the ambitious scenario across the three cities combined (reflecting in part the current, relatively limited rate of donation in the restaurant sector). If restaurant donation could be taken to scale as shown in our maximum scenario, however, the opportunities are substantial.
- Much of the food that institutions and restaurants could potentially donate would be prepared food (such as entrees and side dishes). Indeed, more than one-third of all the untapped potential we found under the ambitious scenario could be prepared food items. These ready-to-eat foods can be particularly useful to organizations like homeless shelters, senior feeding programs and others that provide prepared meal services, often to those most acutely food insecure.

We also looked at the potential for food donation to reduce the amount of food being discarded as estimated in NRDC's baseline analysis. We found that in the restaurant sector, just 2 percent to 3 percent of the total amount of food discarded as estimated by NRDC could be avoided through donation even at the hypothetical "upper limit" rates reflected in our maximum scenario. Figures ranged from 5 percent to 10 percent of food discarded among the hospitality, healthcare and university/college sectors. To a significant degree, these modest percentages reflect the very large portion of discarded food in foodservice settings that is post-consumer, such as plate waste, that is not suitable for donation. NRDC estimates that 65 percent to 90 percent of total food wasted in foodservice settings occurs on a post-consumer basis given dialogue with a range of industry stakeholders.

By contrast, we estimate that more than one-third of the total amount of estimated food discards in the retail grocery sector[5] could potentially be donated under optimal conditions. In part, this reflects that nearly all food discarded from grocery stores is "pre-consumer" and that much of it may be appropriate for human consumption if rescued promptly. For municipalities motivated to divert food from landfills through donation efforts, the grocery sector is a good place to focus.

We also looked at the potential for food donation to play a role in avoiding the greenhouse gas emissions (GHG) that occur when food is disposed of in landfills. Across the three cities combined, we estimate that 14,075 metric tons of CO_2 equivalents could be avoided if the untapped potential under our maximum scenario was donated and consumed rather than landfilled. This relatively modest figure reflects the fact that more than 90 percent of the GHG emissions associated with wasted food occur before the disposal phase.[6] Nevertheless, food donation can contribute to municipalities' GHG reduction targets while advancing the more central aims of addressing near-term food insecurity and curtailing wasted food.

By putting a price tag on the financial investments that would be needed in Denver, we hope to shed light on the cost of rescuing and distributing donated food.

Our analysis has shown the significant potential for grocers, restaurants and institutions within each city to play a bigger role in addressing unmet food needs in their community. But food rescue does not come for free. The costs of rescuing food—from enlisting donors, to transporting food, storing it, processing it, ensuring food safety and distributing it to populations in need—also must be addressed.

To illuminate these costs and associated investment needs we took a deeper dive in Denver, exploring potential costs of expanded infrastructure and operations as food rescue scales up. Extrapolating from current costs, capital assets, and distribution methods now being used in Denver and with volunteer labor costed at Colorado's current minimum wage, we estimate operating costs to achieve the ambitious scenario (901 tons of additional food) to be $2.0 million per year. Initial minimum capital investments for vehicles and storage of about $213,000 would also be needed. To reach the maximum scenario (an additional 4,232 tons), additional operating costs of $6.2 million would be needed per year, along with initial minimum capital investments for vehicles and storage of about $745,000.

Our analysis is a first-of-its-kind effort to estimate the amount of additional food donations that could potentially be sourced from area retailers, restaurants and institutions in Denver, New York and Nashville, and the degree to which those added donations could address those cities' meal gap. By putting a price tag on the financial investments that would be needed in Denver, we hope to shed light on the cost of rescuing and distributing donated food.

NRDC has also developed a streamlined calculator tool so that other cities can tailor our methodology to local circumstances and aspirations and explore their own potential for increased food rescue. This data can inform dialogue among city policymakers, businesses, philanthropists, anti-hunger advocates and food insecure communities themselves about what is possible and the investments needed to realize that potential. Doing so holds the promise of reducing how much food goes uneaten and addressing near-term food insecurity while improving environmental outcomes. We hope our learnings will inform dialogue in communities around the country and inspire additional cities to undertake similar analyses.

Chapter 1: Overview

Photo courtesy of MetroCaring

As awareness of wasted food grows across the country, cities are increasingly paying attention to how much food goes uneaten in their community. Indeed, cities have many reasons to be concerned. Food insecurity is a widespread challenge. Cities are typically responsible for providing solid waste services for area businesses and residents. And a growing number of cities have greenhouse gas emission, recycling and other sustainability goals in place that are either helped or hindered by how they address wasted food. All of these factors make it important for cities to understand how much food is currently going uneaten and to develop plans for reducing it.

Indeed, up to 40 percent of the U.S. food supply goes uneaten every year.[7] Along with that wasted food goes all the water, energy, pesticides, fertilizer, labor and other inputs that go into growing, shipping, processing, marketing and preparing it. When landfilled, wasted food also generates methane, a powerful greenhouse gas.

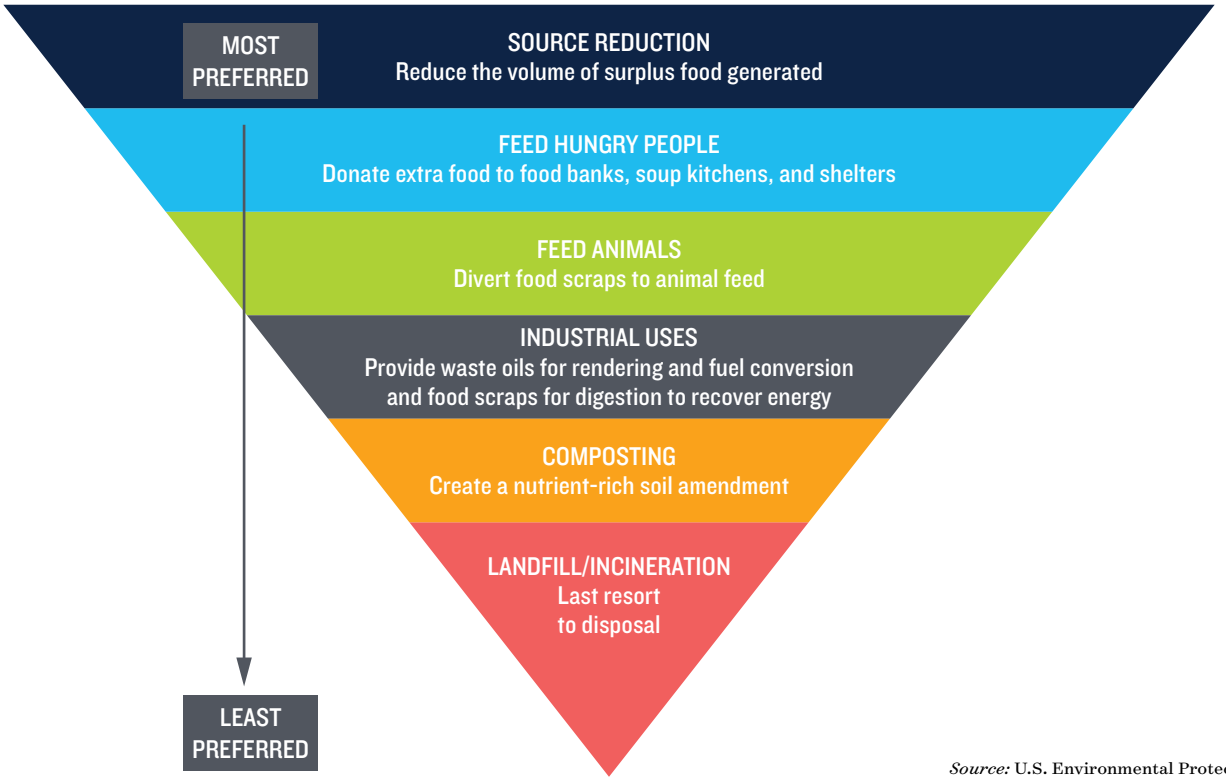
As reflected in the U.S. EPA's "Food Recovery Hierarchy," cities and other stakeholders can take a number of approaches when grappling with wasted food. Source reduction (or "prevention") efforts aim to reduce the volume of surplus food generated. By keeping food from going to waste in the first place, prevention efforts offer the greatest environmental benefits by reducing the amount of food produced, processed, shipped, packaged and so on.

Prevention is also where financial benefits are maximized, as businesses and consumers avoid purchasing food that goes unused.

When prevention efforts are not enough to keep food surpluses from occurring, the next preferred strategy is to make sure food is re-directed to people in need. Food rescue efforts provide a bridge between food donors, such as grocery stores and restaurants, and food insecure individuals. In communities across the country, food rescue plays a key role in meeting near-term food needs. (A growing number of enterprises are also finding ways to turn surplus foods into business ventures, although these were beyond our scope.)

At the same time, it must be acknowledged that food donation in itself does not address the underlying drivers of poverty and the food insecurity that can result from it. It is not a systemic solution and a much more comprehensive suite of strategies is needed to truly grapple with the poverty that drives food insecurity. Conversely, it does not make sense to landfill good food when all too many lack a reliable supply of food to their tables. It is in that spirit that our research has explored the degree to which selected cities could pursue the dual goals of addressing food insecurity and reducing how much food goes to waste by expanding food rescue efforts in their community.

FIGURE I: FOOD RECOVERY HIERARCHY



Source: U.S. Environmental Protection Agency

More than 41 million people are considered food insecure in the United States,[8] meaning that they live in households with limited or uncertain access to adequate food. Indeed, estimates suggest that low income adults and children in the U.S. lacked the financial resources to afford the equivalent of more than 7.6 billion meals in 2015 (the most recent year for which data is available).[9]

This figure—the "meal gap"—reflects the additional dollar amount that individuals estimated to be food insecure report needing, on average, to purchase just enough food to meet their food needs. That dollar amount is then translated into meal equivalents for counties and states based on food prices in a given locale.[10,11,12,13] By characterizing the gap between what individuals can afford and what food they need, the meal gap provides an important reference point for hunger relief efforts.

While the amount of food now being donated is substantial, there is a great deal of opportunity to expand. In sectors such as restaurants and institutional foodservice, food donation programs in most cities are still in relatively early stages of development as an array of start-ups and established rescue groups work to grow their operations.

Even in the grocery sector, there is significant potential to ramp up donations, particularly of healthy perishable foods like fruits, vegetables, meat, dairy and deli items.

How big is this as-yet untapped supply of surplus, potentially rescuable food? What additional investments in food rescue infrastructure would be needed for a city to more fully tap that potential? And if it did so, how far could a city go in addressing its meal gap? These are the questions we set out to explore in our research.

We encountered a variety of challenges along the way. For instance, food donation is highly context-specific. Operating dynamics can differ greatly from one food establishment to the next, sometimes facilitating food donation and other times impeding it. State and local health and safety regulations vary and misconceptions abound about what food donations are permitted at the local level. Businesses have their own internal policies (or no policies) about what foods can be donated and under what circumstances.

As we designed our methodology, we sought advice from various food rescue stakeholders about key design elements. For instance, should we omit from our figures

very small food quantities (e.g. pick-ups of less than 15 pounds per location), foods that may have limited nutritional value or those that may already be available in excess (such as bread and other bakery items)?

We were encouraged not to speculate on these issues or remove these items from the data set. Instead, we have tried to sketch out a comprehensive picture, enabling others to make their own determinations about issues like minimum pick-up volumes and the desirability of different food types.

As we conducted this analysis, we were fortunate to receive invaluable input and data from leading organizations like Food Recovery Network, Feeding America, Food Donation Connection and LeanPath. A wide array of industry stakeholders in the institutional foodservice, restaurant and grocery sectors also provided expert insight.

A variety of important issues fell outside our scope. For instance, we did not attempt to assess the degree to which future food waste prevention efforts or industry consolidation may influence the supply of food that could be rescued. In developing our estimates, we did not speculate on whether the rescue infrastructure is currently in place to handle the food volumes estimated here. In many cases, it isn't. It was also beyond our scope to explore critical drivers of food insecurity such as wage rates, and access to jobs, education, transportation or housing. That said, food rescue clearly must be paired with heightened efforts to address the underlying, structural drivers of poverty that lead to hunger in America.

We also recognize that hunger relief organizations can make a variety of decisions when additional food donations become available. A homeless shelter, for instance, could cut back on grocery store purchases, saving scarce budget dollars. Or they might replace donated grocery items with donated prepared foods, reducing the time spent preparing food and re-directing that labor toward other activities. Others might choose to replace lower quality donated food with higher quality donations when it becomes available, while serving the same number of people. As a result, we can't assume that increased donations will necessarily translate one-to-one into a greater amount of food reaching food insecure populations. However, we can identify the tonnage of additional food that could potentially be available for donation, positioning local communities to decide how best to deploy those added resources.

Given data limitations and the challenges of developing analytical methods in the face of uncertainty, our analysis should be interpreted as an illustration of the potential under a given set of chosen parameters. Also, our methodology was crafted for use at a city-wide level to explore the potential for increased donation in key sectors of the city's food economy, namely among food retailers, institutions and restaurants. It should not be applied to individual businesses. We hope that future studies will further refine our methods and data.

Photo courtesy of MetroCaring

NRDC has also developed a web-based geovisualization tool[14] that plots potential sources of food from each sector on maps of the three cities. Data can be split out by sector and amount, providing a visual picture of where opportunities are located geographically within the three cities. NRDC has also developed a streamlined calculator tool[15] so that other cities can tailor our model to local circumstances and aspirations and explore their own potential for increased food rescue.

In the next section of the report, we outline our methodology for assessing additional amounts of surplus food that could potentially be rescued. This is followed by our findings, including cross-cutting themes and the potential for expanded food rescue in the three cities. Lastly, we explore the financial investments in food rescue infrastructure that would be needed in Denver, specifically, to more fully realize its potential for food rescue. Associated mathematical formulae, more insights on methodological limitations, and future research needs are provided in the appendices.

Chapter 2: Methodology for Assessing Additional Amounts of Surplus Food That Potentially Could Be Rescued

Photo courtesy of MetroCaring

In this chapter, we present our methodology for estimating the amount of surplus food that potentially could be available for rescue from selected sectors of the local food economy. This provides critical context for interpreting the results discussed later in the report.

Our methodology is rooted in four core elements:

1. Identification of relevant businesses and institutions located in the three cities, focusing on the retail, restaurant and institutional foodservice sectors
2. The percentage of area retail, restaurants and institutional foodservice providers we include as potential food donors (i.e. the participation rate)
3. Metrics to quantify how much surplus food potentially could be available for donation from those business and institutions (i.e. the donation rate)
4. Estimated amounts of food that are currently being donated by these sectors within each city. By deducting amounts currently being donated, we arrive at the "untapped potential" for increased food donation.

We discuss each of these elements below and outline how we combined them in the two scenarios that we explored.

IDENTIFYING RELEVANT FOOD-RELATED BUSINESSES AND INSTITUTIONS IN THREE CITIES

Our research focused on consumer-facing business and institutions, specifically food retail (grocery retail and convenience stores), hospitality (including hotels and larger motels), universities and colleges, healthcare (including hospitals and skilled nursing facilities), K-12 schools, caterers, restaurants (full-service and limited-service), and coffee shops.

We used North American Industry Classification System (NAICS) codes[16] to identify these entities in the three cities, drawing from a proprietary database. This approach for geo-locating relevant organizations parallels the methodology used in NRDC's food waste baseline analysis, although with some differences in the types of business sectors being addressed and how businesses are grouped within sectors.

We used the following geographic boundaries for our research:

- Denver: the City and County of Denver, the boundaries of which coincide with one another
- New York City: the five boroughs of New York, Kings, Queens, Richmond and the Bronx, represented by their county boundaries
- Nashville: the boundaries of the Nashville-Davidson Metropolitan government.[17]

RUNNING TWO SCENARIO ANALYSES: AMBITIOUS AND MAXIMUM

We explored two scenarios to estimate the amount of surplus food that could potentially be available for rescue. While we could have chosen a variety of other scenarios, we offer these two to illustrate the range of possibilities:

- **Maximum Scenario:** Our maximum scenario characterizes the maximum amount of surplus food in the retail, restaurant and institutional sectors within each city that we believe could, hypothetically, be donated. This scenario estimates potentially rescuable surpluses at 100 percent of area businesses and institutions and our most optimistic assumptions about the amounts of surplus food that could potentially be suitable for donation under optimal conditions. As such, the maximum scenario describes the upper-most limit of what we believe to be theoretically possible.
- **Ambitious Scenario:** The ambitious scenario describes the amount of rescuable food that could be available using more realistic assumptions and existing donation patterns to describe an ambitious yet attainable set of possibilities. As such, the ambitious scenario is more rooted in current rescue realities and embodies a more "middle of the road" set of assumptions. It acknowledges, for instance, that donation activity in sectors such as restaurants is currently more limited and will take time to grow given the challenges of rescuing prepared food from many disparate locations.

These scenarios are driven by two factors. First, the percentage of locations in a given sector that we characterize as potential donors (i.e. the participation rate) and, second, the estimated rate of potential donation by entities within that sector (the donation rate), for instance tied to sales or estimated pre-consumer food discards as detailed below.

ASSUMING PARTICIPATION RATES BY SECTOR

In the maximum scenario, we include 100 percent of identified businesses and institutional locations within each city. Under the ambitious scenario, we chose a percentage of locations for each sector scaling up from current participation in donation efforts as shown in the chart at right. For instance, many grocery retailers already donate (e.g. 70 percent of them in Nashville currently donate to some degree[18]). We used an 80 percent participation rate for the grocery sector in our scenario, reflecting high current rates of participation and the opportunity for some additional retailers to begin donating.

ASSUMED PARTICIPATION RATES BY SECTOR (% OF LOCATIONS INCLUDED)

SECTOR	AMBITIOUS SCENARIO	MAXIMUM SCENARIO
RETAIL GROCERY	80	100
RESTAURANTS (FULL SERVICE AND LIMITED SERVICE)	15	100
UNIVERSITY & COLLEGE	50	100
K-12	50	100
HOSPITALITY	50	100
HEALTHCARE	50	100
SMALL RETAIL / CONVENIENCE STORES	15	100
COFFEE SHOPS	15	100
CATERERS	50	100

Participation in donation efforts appears to be much lower in other sectors. For instance, we estimate that less than five percent[19] of one million-plus restaurants[20] in the United States currently donate food. As a result, we explored a participation rate of 15 percent for restaurants in our ambitious scenario and used this rate for convenience stores and coffee shops as well. In the university sector, we estimate that fewer than 10 percent of universities and colleges currently donate.[21] However, most cities have a relatively modest number of universities, which bodes well for donor recruitment efforts. As a result, we explored a 50 percent participation rate for universities in our scenario, and used that rate with other institutions as well.

ASSESSING DONATION RATES

We drew on the best available data we could locate for each sector to estimate amounts of surplus food that could potentially be donated. We leveraged nationwide data on actual retail grocery donations from Feeding America[22] and data on actual donations from full service restaurants, limited service restaurants, convenience stores, and coffee shops through the Food Donation Connection[23] network. Donation data were then tied to estimated per-location annual sales figures. That allowed us to generate metrics framed as "pounds-donated-per-$100 sales" that describe the relationship between sales and current, actual donation rates.

Our analysis was also informed by the statistical distribution of "pounds-donated-per-$100 sales" within these datasets. For instance, the median donation rate (or 50th percentile) shows the rate of donation for which half of current donors donated less and half donated more. We

used the 75th percentile of current donations for many of our ambitious estimates, reflecting best practices among existing donors. This approach has allowed us to ground our analysis in existing donation patterns through the Feeding America and Food Donation Connection networks, the largest national networks operating in their respective sectors of the food economy. While they are not necessarily representative of all donation, they reflect the most extensive nation-wide data available.

In institutional sectors, data on current donation rates was more limited. Instead, we collaborated with LeanPath,[24] maker of food waste tracking platforms used to monitor pre-consumer food discards in commercial foodservice settings. LeanPath provided aggregated, sector-specific data on documented rates of pre-consumer food discards among a subset of organizations in the hospitality, healthcare and university sectors. For the Kindergarten through 12th-grade schools (K-12) sector, data was more limited, making our metrics more speculative in nature. We decided against including airports and event centers in the analysis due to data limitations.

We also note that some food-based businesses elect to give surplus foods to their employees (some of whom may themselves be challenged to afford the food they need), rather than donate it. While we were not able to quantify this practice, we recognize that it may reduce the amount of food that is actually available for donation.

IDENTIFYING AMOUNTS CURRENTLY BEING DONATED

In each city, we gathered information on amounts of food currently being donated by relevant business and institutions located in each city. This data was provided by a subset of area food rescue organizations and covers the most recent twelve-month period for which data was available. We then deducted these amounts from both scenarios. Deducting current donations allows us to quantify the currently untapped potential under each scenario. This is particularly important in a sector such as retail grocery where well-developed donation programs are in place.

Through our more intensive research in Denver with food rescue organizations, we documented amounts now being rescued at a reasonably granular level. In Nashville, rescue efforts in the grocery retail sector are well documented, with data from other sectors partially captured. In New York City (NYC), due to its unique complexity, only partial data was available to us for the retail sector and was absent for the remaining sectors. As a result, current donations in NYC are likely to be understated to a significant degree. In all three cities, donated foods that are picked up directly by last-mile organizations such as homeless shelters without involvement of a food rescue organization are not reflected. This will tend to understate existing donations from the restaurant sector, in particular, where direct pick-ups may be more common.

That said, we were able to identify the following minimum amounts of food currently being donated from relevant businesses located within the three cities:

IDENTIFIED CURRENT DONATIONS FOR EACH CITY (IN TONS PER YEAR)

	DENVER[25]	NEW YORK CITY[26]	NASHVILLE[27]
Grocery Retail	2,526	3,640	1,209
Restaurants	8	-	1
Institutions	5	-	-
TOTAL	**2,539**	**3,640**	**1,210**

It is also important to note how the geographic boundaries of our analysis influence the data. We looked only at specific consumer-facing sectors and only donation from locations within our chosen geographic boundaries. By contrast, many large rescue organizations work with additional types of donors and obtain significant amounts of food from sources beyond the city limits including manufacturers, distributors, agricultural commodities sourced regionally and nationally, and commodities provided through U.S. government programs. This pattern is common in the food banking arena, highlighting that foods donated by consumer-facing businesses and institutions within a given city are but one element of a broader food rescue landscape.

COMPARING RESCUE "POTENTIAL" TO THE ESTIMATED MEAL GAP

In addition to estimating how much additional surplus food could potentially be rescued in our three cities, we compared those amounts of food to each community's estimated meal gap, working from Feeding America data. To translate food tonnage into meal equivalents we assume that "meals" weigh 1.2 pounds on average.[28] In doing so, we also acknowledge that some food may go to waste after the point of donation (whether within the hunger relief system or after it is provided to food insecure individuals). We did not attempt to deduct these amounts due to the limited availability of data.

DEVELOPING SECTOR-SPECIFIC METRICS

Lastly, we developed donation metrics specific to each sector. These are outlined below. The strengths, limitations and data sources for each sector are summarized in Appendix A. The mathematical formulae associated with the metrics are provided in Appendix B.

RETAIL GROCERY

Data Sources: For the retail grocery sector, we used actual donation data provided by Feeding America, comprising 19,308 store locations from 20 major retail grocers for a one-year period ending June 30, 2016.[29] The Feeding America data includes donations directly from stores, donations from retailers' distribution centers, and food donated by salvage/reclamation companies that handle unsold product for some retailers. We also gathered insight and data from a variety of retailers about their current donation programs and perceived opportunities for expansion. Separately, for every grocery retail location in the dataset, NRDC accessed estimated annual total sales data via a proprietary database.

Model: Both our ambitious and maximum scenarios use the 75th percentile of actual grocery donations in the above dataset (measured as pounds-donated-per-$100 in total annual retail sales per location and reflecting relevant regional variations) of 0.53 lb/$100 sales. Grocers that donate at this 75th percentile are often able to do so by ramping up donation of perishable items. Perishable food categories including produce, dairy, meat and deli represent a substantial 53 percent of all U.S. grocery sales.[30] This large share of perishables among U.S. grocery sales and input from industry leaders suggest that donation rates could expand substantially if rescue infrastructure for perishables was adequately scaled up.

For the ambitious scenario we assume 80 percent of stores donate at the 75th percentile rate. The maximum scenario reflects 100 percent of identified locations.

Limitations: Our grocery retail model is based on a substantial, national dataset of actual donations and is likely a robust estimate of current donation rates for the entities involved. However, this data is largely based on large corporate grocery chains and may be less accurate when applied to smaller and independent grocers, or to retailers that have a relatively larger share of non-food sales.[31]

RESTAURANTS (FULL-SERVICE AND LIMITED-SERVICE)

Data Sources: Our analysis of the restaurant sector drew on aggregated, sector-level donation data provided by Food Donation Connection (FDC) and interviews with industry leaders. The FDC data[32] captured actual donation patterns among 6,124 full and limited service restaurant locations in 2015 and 2016. (Full service restaurants are those offering table service while in limited service restaurants patrons typically order or select items and pay before eating.[33]) Food Donation Connection has facilitated the donation of more than 500 million pounds of food across the country since its inception in 1992. The majority of this has been prepared food donated by major chain restaurants. Donation data were then tied to average sales-per-location figures for the companies donating through FDC.[34]

Model: We used the 75th percentile of current donation rates among FDC donors in our ambitious scenario. We used the 90th percentile for the maximum scenario. That yields the following metrics for surplus food that potentially could be donated:

DONATION RATES FOR FULL- AND LIMITED-SERVICE RESTAURANTS (POUNDS PER $100 OF ANNUAL SALES)

	50TH PERCENTILE OF CURRENT DONATION RATES	75TH PERCENTILE OF CURRENT DONATION RATES	90TH PERCENTILE OF CURRENT DONATION RATES
Full-service restaurants	0.063	0.099	0.146
Limited-service restaurants	0.032	0.070	0.128

We believe that less than 5 percent[35] of one million-plus restaurants[36] in the United States currently donate food. For the ambitious scenario we assume that 15 percent of restaurant locations participate in donation, reflecting substantial expansion from current levels. All locations are included in the maximum scenario.

Limitations: These data reflect donations primarily by national restaurant chains in the limited service and casual dining categories and may be less applicable to other restaurant categories and non-chain contexts. In the limited service sector, pizza restaurants were likely over-weighted relative to other types of limited service restaurants although we have attempted to eliminate some skew in the underlying data source. Due to data confidentiality concerns, we were unable to review per-location donation data, confirm the accuracy of sales figures used, or identify potential spatial sampling bias given the geography of donations reflected in the underlying data.

HOSPITALITY, UNIVERSITIES AND COLLEGES, AND HEALTHCARE

Data Sources: In the absence of a national database of actual food donations by universities and colleges, healthcare and hospitality foodservice, we used an alternate approach for these three institutional sectors. Our estimates of potential food donations are based on pre-consumer food discards recorded through the LeanPath tracking platform.[37] The LeanPath data we used captured detailed, daily waste tracking at 12 institutional foodservice locations (two hotels, seven universities/colleges, and three hospitals) during the initial months after the LeanPath tracking platform was launched at these locations. The data covered an average of 3.2 months of initial LeanPath use.[38]

Given the reduction of pre-consumer waste that typically occurs once LeanPath tracking commences and the possibility that LeanPath users are more motivated to reduce waste than their industries overall, we grossed up the sector-specific LeanPath per meal waste rates by 20 percent[39] to better reflect pre-intervention waste rates. In addition, we analyzed data from the Food Recovery Network[40] on existing food donations through its network of university and college chapters. This data included per-semester donations over the span of three years from 201 universities.

Model: For universities and healthcare, we first estimated the approximate number of meals served per year based on the number of students and beds, respectively, for such institutions in the three cities.[41] We then applied per-meal pre-consumer data from LeanPath,[42] focusing exclusively on those portions of pre-consumer food discards that were recorded in LeanPath as resulting either from overproduction or "expired."

We believe that foods discarded due to overproduction or expiration are the most likely candidates for donation (as distinct from trim waste and items that were over-cooked, spoiled or discarded for other reasons that may make them inappropriate for donation). We note that under LeanPath's tracking system, "expired" foods would include those that are appropriate for human consumption but may have passed a 24-hour window, for example, between when a sandwich was made and when it can be sold under a given food service company's internal policies. In the LeanPath study, documented pre-consumer per-meal waste rates were as follows:

Universities and colleges: 0.04 pounds per meal
Healthcare: 0.11 pounds per meal

The portion of pre-consumer food discards that were identified in the LeanPath study as being due to overproduction or expired (combined) are 56 percent of total pre-consumer discards for Universities & Colleges, 75 percent for Healthcare and 63 percent for Hospitality. The bulk of this is due to overproduction.

In the hospitality sector, a reliable mechanism was not available for estimating the number of meals served. Instead, we utilized the NRDC baseline estimate for total food going to waste in the hospitality sector and assumed 15 percent[43] to be pre-consumer. The LeanPath data on overproduced and expired foods in the hospitality sector was then applied to the estimated tonnage of pre-consumer food discards. We excluded lodging locations with fewer than 30 employees on the assumption that foodservice would either not be provided or not provided on a significant enough scale for meaningful rescue potential.

For the ambitious scenario, we assume that 50 percent of the overproduced and expired foods could be donated. We used 75 percent in the maximum scenario. This makes the institutional estimates better parallel our retail and restaurant figures which are based on actual donations and are thus tempered by existing logistical challenges for donors and rescuers, the vagaries of local food safety regulations around the country, etc. It also reduces the likelihood that expired items that aren't appropriate for donation are excluded from the figures.

In terms of donor participation, we included 50 percent of locations in the ambitious scenario. For instance, in Denver, this would be equivalent to 11 colleges/universities, 5 hospitals, 28 skilled nursing facilities, and 83 hotels/motels. For the maximum scenario, we apply this rate to 100 percent of locations.

Limitations: The per-meal data is based on a small number of locations covering a short period of time. As overproduction and expired data was available to us only on an aggregated basis by sector, we could not correct for possible bias or identify sources of skew in the underlying data. Little data is available on the portion of total food waste in the hospitality sector that is typically pre-consumer. We also assume that data based on hotels can be applied to the hospitality sector as a whole.

CATERERS

Data Source: Data on food donation and food discards in the (non-institutional) catering sector was extremely limited. As a proxy, we adapted our approach for the hospitality sector above.

Model: We assume 15 percent of total discarded food among caterers that was estimated under NRDC's baseline analysis to be pre-consumer. LeanPath data for hotels shows that an average of 44 percent of the reported pre-consumer waste resulted from over-production. We used that overproduction figure and increased it by 15 percent to recognize that overproduction is typically required in catering contracts (e.g. 10 percent overproduction required relative to the intended number of guests, plus some additional leeway for the caterer to ensure they can meet the 10 percent requirement). We did not factor in expired foods on the assumption that independent caterers are less likely to carry significant inventories.

For the ambitious scenario, we assume that 50 percent of the resulting amounts could be available for donation, with 50 percent of caterers donating. For maximum, we include 75 percent of estimated tonnage and apply it to all caterers.

Limitations: Our approach is limited by the lack of specific donation or pre-consumer waste data for independent caterers.

K-12 SCHOOLS

Data Source: Our data on actual food donation by K-12 schools was provided by three school districts.[44] We also interviewed several school foodservice professionals.[45]

Model: We conservatively assume one pound per-student per-year of potentially rescuable food for the ambitious model and four pounds per-student per-year for the maximum model. The ambitious scenario estimates potential donation figures if schools serving 50 percent of students in the city participate in donation efforts. This approximates the 50 percent participation rate for other institutional food service sectors. All school locations are included in the maximum scenario.

Limitations: Our actual donation data was based on a small number of locations. K-12 schools (whether public or private) vary greatly in their operating environments, making it important to groundtruth the potential for donation on a more localized basis than our scope of work afforded. Although these figures are rough, they provide a starting point for further research and acknowledge the growing momentum around food donation in the K-12 sector.

SMALL RETAIL/CONVENIENCE STORES AND COFFEE SHOPS

Data Sources: Similar methods and data sources were used for small retail/convenience stores and coffee shops so they are presented jointly here. Aggregated data on actual donation rates in 2015 for each sector were provided by Food Donation Connection based on donations from 488 convenience stores and 5,306 coffee shops.[46]

Model: Donation data for convenience stores and coffee shops (separately) were scaled using averaged sales-per-location figures for each sector provided by FDC. This yielded the same type of pounds-donated-per-$100-annual sales metrics that we used in the retail grocery and restaurant sectors. The 75th percentile was used for our ambitious scenario with the 90th percentile used for maximum scenario. We applied available data on convenience stores to food retailers with fewer than 10 employees based on proprietary business informatics. That yielded the following rates of donation as measured in pounds per $100 of annual sales:

DONATION RATES FOR SMALL RETAIL/CONVENIENCE STORES AND COFFEE SHOPS (POUNDS PER $100 OF ANNUAL SALES)

	CURRENT MEDIAN DONATION RATE	AMBITIOUS SCENARIO (75TH PERCENTILE OF CURRENT DONATION RATES)	MAXIMUM (90TH PERCENTILE OF CURRENT DONATION RATES)
Small Retail/ Convenience Stores	0.700	0.943	1.135
Coffee Shops	0.072	0.136	0.183

For the ambitious scenario we assume that 15 percent of small retailers/convenience stores and coffee shops participate in donations in parallel with our assumption for restaurants. All such businesses are reflected in the maximum scenario.

Limitations: Due to data confidentiality concerns, we were unable to inspect per-location donation data and cannot confirm whether the average per-sector sales figures are accurate for this sample or whether the underlying distributions show skew that would prevent the use of parametric (normality-assuming) methods. The number of locations for small retail/convenience stores and coffee shops is likely understated for some cities due to limitations in the underlying data source.

Chapter 3: Findings

Photo courtesy of MetroCaring

We now share the results of our analysis. We begin with themes that cut across all three cities and then explore results specific to Denver, New York City and Nashville.

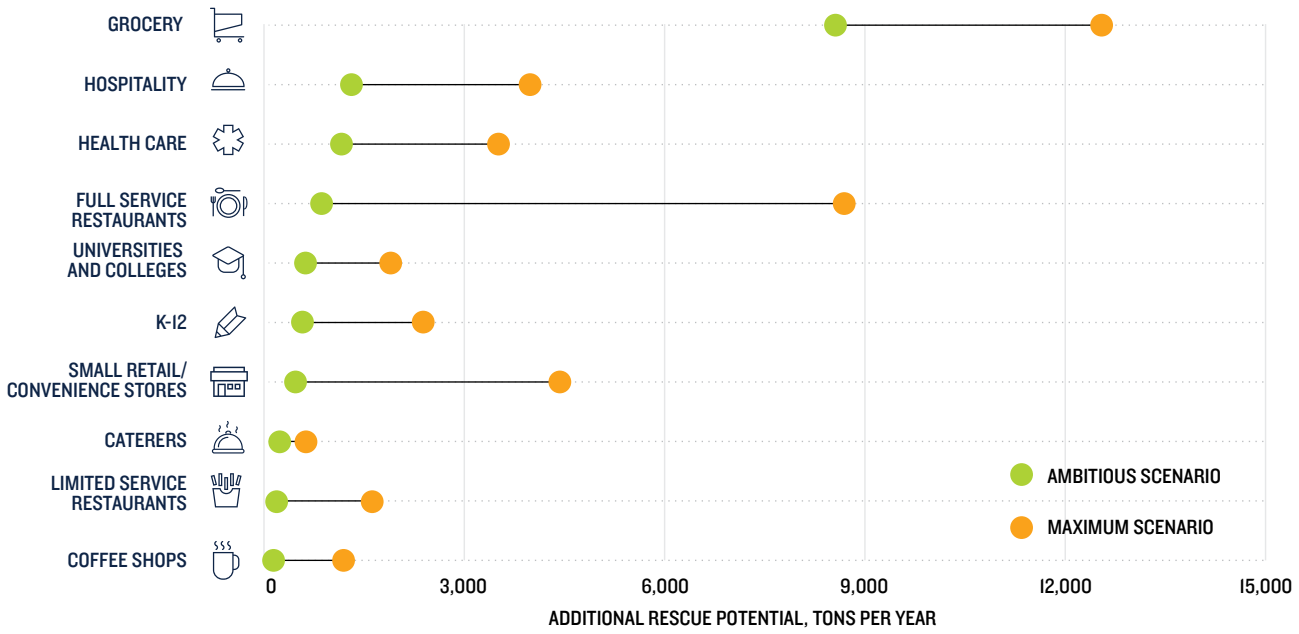
CROSS CUTTING THEMES

- **Across all three cities, grocery retail showed the greatest untapped potential among the sectors we reviewed under both the ambitious and maximum scenarios.** For instance, it represents more than 60 percent of the untapped potential under the ambitious scenario after current donations have been deducted, upwards of 8,600 tons. Although there is a well-established system for rescuing surplus foods from the grocery sector and many large retailers, particularly from large national supermarket chain stores, currently donate to some degree we found there is significant potential to secure additional donations—primarily of perishable foods, such as fruits and vegetables, meat, dairy and deli items.
- **The institutional food service sectors we reviewed (hospitality, healthcare, universities and K-12 schools) also have the potential to provide significant volumes of quality prepared food.** Indeed, about 26 percent of the untapped potential under the ambitious scenario across the three cities combined lies with these sectors (or more than 3,700 tons). Our analysis suggests that hospitality (e.g. hotels) and healthcare offer the strongest potential among the institutional sectors reviewed, with 9 percent and 8 percent of the untapped potential, respectively.
- **Restaurants make up about 7 percent of the potential we see under the ambitious scenario (beyond existing donations) across the three cities combined. Most of this is from full service restaurants.** (Full service restaurants are those offering table service, while in limited service restaurants, patrons typically order or select items and pay before eating.[47]) While restaurants represent a larger portion of overall wasted food, much of this occurs after the food is served. Also, we estimate that fewer than 5 percent of all restaurants in the country currently donate. Under our maximum scenario (including incorporation of 100 percent of restaurant locations rather than the 15 percent used in the ambitious scenario) restaurants could hypothetically provide an additional 10,300 tons of food (or 25 percent of the untapped potential under that scenario), a substantial figure. The restaurant sector accounts for nearly 75 percent of the business locations reviewed in Denver, New York City and Nashville.

The graphic below highlights the potential we see for additional donations within the cities under review. This chart captures combined data from the three cities and reflects both our ambitious and maximum scenarios.

Our analysis suggests that hospitality (e.g. hotels) and healthcare offer the strongest potential among the institutional sectors reviewed.

POTENTIAL FOR ADDITIONAL FOOD RESCUE BY SECTOR FOR THE THREE CITIES (COMBINED)



Below we highlight more specific figures by sector and the number of locations with which those quantities of food are associated. The right-most column shows the potential under the maximum scenario on a per-location basis, measured in average tons per year. This data illuminates, among other things, the vast number of full and limited service restaurants in the three cities and the much more modest number of institutional foodservice locations, such as hospitality, healthcare and college/university facilities.

RESCUE POTENTIAL FOR THE THREE CITIES (COMBINED)

	UNTAPPED POTENTIAL UNDER AMBITIOUS SCENARIO (TONS/YEAR)	UNTAPPED POTENTIAL UNDER MAXIMUM SCENARIO (TONS/YEAR)	TOTAL LOCATIONS (USED IN MAXIMUM SCENARIO)	MAXIMUM OPPORTUNITY PER LOCATION (TONS/YEAR)
RETAIL GROCERY	8,567	12,553	669	18.76
HOSPITALITY	1,328	3,985	361	11.04
HEALTH CARE	1,169	3,507	300	11.69
FULL SERVICE RESTAURANTS	877	8,683	18,210	0.48
UNIVERSITIES & COLLEGES	633	1,903	181	10.51
K-12	599	2,398	2,486	0.96
SMALL RETAIL/CONVENIENCE STORES	494	4,434	952	4.66
CATERERS	213	640	702	0.91
LIMITED SERVICE RESTAURANTS	132	1,613	4,335	0.37
COFFEE SHOPS	132	1,186	2,245	0.53
TOTAL	**14,145**	**40,902**	**30,441**	**1.34**

The per-location data shown above can inform the prioritization of expanded rescue efforts and the types of rescue infrastructure needed to realize the potential from different types of donors. Food type, quality and geographic proximity should also be taken into account, along with other factors.

This cut on the data highlights the large, currently untapped potential on a per-location basis in the retail grocery sector. Given the scale of their foodservice operations, health care facilities, hospitality locations (such as hotels) and universities and colleges can also hold the potential for substantial donations per location. Small retail/convenience stores also show significant potential per location. The remaining sectors remain important, but appear to offer substantially smaller potential per location.

Additional themes including the following:

- **Unlocking the untapped potential in the retail grocery sector will require increased investment in transportation capacity to enable more frequent store pick-ups** (e.g. increasing store pick-ups from 1 time to 2 times per week to 4 times to 5 times per week for large stores[48]). Such investments can leverage the broad base of relationships and donation activities that already exist in the grocery sector, particularly among larger chains. Additional infrastructure will be needed to handle and store perishables at the rescuer level, along with expanded capacity to distribute it rapidly through organizations that interact directly with food insecure populations.
- Restaurants account for 44 percent of all the discarded food that was estimated through NRDC's analysis of baseline food waste rates in the three cities. However, the majority of the food being discarded in restaurants, as in institutions, is post-consumer (such as plate waste) and is not suitable for rescue. In fact, **NRDC estimates that 65 percent to 90 percent of total food wasted in foodservice settings occurs on a post-consumer basis given dialogue with a range of industry stakeholders.**
- **The restaurant sector involves large numbers of locations, typically with relatively small volumes of rescuable food per location.** It is critical that rescue efforts in this sector be designed to maximize efficiency, focusing on restaurants that offer significant volume and that are in proximity to one another and to populations in need. Other key strategies include prioritizing locations offering the most desirable types of food, transporting food directly from the donor to locations where it can be used, focusing on restaurant locations that can freeze surplus food to enable less frequent, larger pickups, use of more nimble rescue systems, and optimized pick-up routes.

Photo courtesy of MetroCaring

- Although institutions and restaurants may donate ingredients such as whole produce, a significant portion of the food they could donate is likely to be prepared food (e.g. entrees and side dishes). **Indeed, more than one-third of all the untapped potential found under the ambitious scenario could be prepared food items.** These ready-to-eat foods can be particularly useful to last-mile organizations such as homeless shelters, senior feeding programs and others that provide meal services, often to those who are most acutely food insecure. Benefits to these organizations can include reduced food preparation time and freeing up scarce budget dollars that may otherwise be spent purchasing food commercially. In these contexts, small amounts, particularly of high value items such as quality proteins that may be under-represented in the current donation stream, can make a big difference.
- **Small retail/convenience stores hold considerable promise based on the existing donation data available in our study.** Given the growing prevalence of grab-and-go foods in many small retail settings, this sector offers opportunities for prepared foods that can be readily used by food assistance programs, along with various packaged grocery items. Overall, we found less overall potential in sectors like catering and coffee shops, although our coffee shop estimates may be understated due to under-representation of these businesses in our underlying database. It is possible that a strategically designed effort to tap caterers that have significant volumes of high quality prepared food could be beneficial. In the next section of the report, we share the results for each of the three cities.

These ready-to-eat foods can be particularly useful to last-mile organizations such as homeless shelters, senior feeding programs and others that provide meal services, often to those who are most acutely food insecure.

DENVER

DENVER'S UNTAPPED POTENTIAL PER YEAR

AMBITIOUS SCENARIO	MAXIMUM SCENARIO
901 TONS	4,232 TONS
1.5 MILLION MEALS	7.1 MILLION MEALS
9.7% OF MEAL GAP	45.7% OF MEAL GAP

TOP SECTORS

- Retail Grocery
- Hospitality
- Small Retail

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With a population of 647,000, Denver has more than 86,000 residents who are considered food insecure, about 13.3 percent of the population. (Note that 2015 figures are used in our analysis.) The community's meal gap is more than 15 million meals per year, representing a need for 9,259 tons of food. Denver has nearly 2,500 retail, restaurant and institutional foodservice establishments that we could identify, with nearly 70 percent being full-service or limited-service restaurants.

Denver is fortunate to have a fairly extensive food rescue system, including a large foodbank and a dozen other rescue organizations of various sizes and models. Through our detailed survey work with Denver-based rescue organizations (see list of participating organizations in the Acknowledgements), we estimate that current donations from retail, restaurant and institutional locations within the City and County of Denver are approximately 2,539 tons per year. These existing donations cover an estimated 27 percent of Denver's meal gap. Food obtained from other sources would complement this figure.

Of these reported current donations, virtually all are from the retail grocery sector. In fact, an impressive 70 percent of the total maximum potential we see in the grocery sector is already being rescued through the work of multiple rescue organizations. Donations from restaurants and institutions (mainly universities) account for only 1 percent of the current donations reported by rescue organizations in our study.

Below we compare the potential we see for additional food rescue with Denver's meal gap. The maximum scenario suggests that, optimally, about 4,232 tons of additional surplus food could be available for donation (beyond amounts currently being donated) from retail, institutional and restaurant locations within the city. If that amount could successfully be rescued and distributed to people in need, Denver could meet an additional 46 percent of its meal gap by rescuing the surplus food that remains untapped in these sectors (beyond current donations).

MEAL GAP ANALYSIS FOR DENVER		
Meal Gap (meals/year)	15.4 million meals	
Meal Gap (tons/year)	9,259 tons	
	AMBITIOUS SCENARIO	MAXIMUM SCENARIO
Total Potential (tons/year)	3,440	6,771
Currently being rescued from focal sectors, from within city boundaries (tons/year)	2,539 (27.4% of meal gap)	2,539 (27.4% of meal gap)
Untapped Potential (tons/year)	901	4,232
Untapped Meal Potential (meals/year)	1.5 million	7.1 million meals
Additional % of Meal Gap that could be met with untapped potential	9.7% of meal gap	45.7% of meal gap

Given that an additional 46 percent of Denver's meal gap could be met if all rescuable food was donated, the city is well positioned to exemplify how strategic growth in food rescue can help meet the meal gap among food insecure residents drawing from surplus foods originating within the city.

The table below unpacks these figures by sector and highlights the potential number of locations involved. Current donations have been deducted, showing the untapped potential under both scenarios.

Retail grocery represents 37 percent of the untapped potential under the ambitious scenario, with an additional 331 tons per year that could potentially be garnered from an estimated 40 retail locations. The hospitality sector is also an important opportunity for Denver as it is little tapped at this point and shows potential for 159 tons per year under the ambitious scenario (nearly 18 percent of the total untapped potential). We estimate that this could be achieved through donation programs with fewer than 30 hotels and other hospitality locations, offering attractive economies of scale for prepared food rescue.

The potential from small retail/corner stores is also substantial (about 16 percent of the total) . Healthcare, K-12 and universities also hold promise given the potential for relatively large individual donations from a modest number of locations.

With restaurants, we estimate that 56 tons of untapped potential under the ambitious scenario between full and limited service restaurants, sourced from just over 250 locations. This represents about 6 percent of the untapped growth potential. Under the maximum scenario (using 100 percent of full service and limited service restaurant locations), the untapped potential rises sharply to 725 tons of surplus food.

Geographically, most potential donors are concentrated in downtown Denver, especially restaurants. This bodes well for expanding rescue operations as geographic concentration of donors can foster more efficient rescue operations.

UNTAPPED POTENTIAL BY SECTOR FOR DENVER (BEYOND AMOUNTS CURRENTLY BEING DONATED)

SECTOR	UNTAPPED POTENTIAL UNDER THE AMBITIOUS SCENARIO (TONS/YEAR)	LOCATIONS INCLUDED IN AMBITIOUS SCENARIO	UNTAPPED POTENTIAL UNDER THE MAXIMUM SCENARIO (TONS/YEAR)	LOCATIONS INCLUDED IN MAXIMUM SCENARIO
RETAIL GROCERY	331	40	1,045	51
HOSPITALITY	159	26	477	53
SMALL RETAIL/ CONVENIENCE STORES	146	22	1,311	153
HEALTHCARE	76	30	229	60
K-12	49	120	196	240
FULL SERVICE RESTAURANTS	46	209	583	1,394
UNIVERSITIES & COLLEGES	44	7	140	15
CATERERS	28	22	85	45
LIMITED SERVICE RESTAURANTS	12	48	142	320
COFFEE SHOPS	9	21	83	141
TOTAL	**901**	**545**	**4,232**	**2,471**

NEW YORK CITY

NEW YORK CITY'S UNTAPPED POTENTIAL PER YEAR

AMBITIOUS SCENARIO	MAXIMUM SCENARIO
11,157 TONS	31,118 TONS
18.6 MILLION MEALS	51.9 MILLION MEALS
8.3% OF MEAL GAP	23.1% OF MEAL GAP

TOP SECTORS

- Retail Grocery
- Hospitality
- Healthcare

As the largest city in the United States, New York City (NYC) has more than 8.4 million residents. Close to 1.3 million of them are considered food insecure. The city's meal gap is estimated at 225 million meals per year, the equivalent of 135,000 tons of food. (All figures are as of 2015.)

We identified nearly 25,000 retail, restaurant and institutional foodservice locations in New York City, roughly ten times the number in Denver. When compared with both Nashville and Denver, we found that New Yorkers appear to rely more heavily on restaurants than retail grocery as a source of food. Also, small retailers (those with fewer than 10 employees in our study) represent a much larger share of the food retail sector in New York City, likely reflecting the more limited presence of large chain retailers and a thriving community of smaller neighborhood markets.

Below we look at the 135,000 tons of food that would be needed to meet NYC's meal gap. We documented 3,640 tons per year of current donations sourced from our focal sectors within our study's geographic boundaries.[49] This amount equates to less than 3 percent of the meal gap, although we recognize that additional donations from area businesses that we were not able to document are meeting

some additional portion of the meal gap. Substantial quantities are also being received from other sectors within NYC that were outside our study's scope and from a variety of sources outside the city.

As shown below, we estimate that an additional 23 percent of the meal gap could be met (almost 52 million meals) if the untapped portion of the maximum scenario was realized. Under our ambitious scenario, NYC could potentially rescue an additional 11,157 tons of food (beyond current donations), equivalent to nearly 19 million meals or more than 8 percent of the meal gap.

MEAL GAP ANALYSIS FOR NEW YORK CITY		
Meal Gap (meals/year)	225 million meals	
Meal Gap (tons/year)	135,000 tons	
	AMBITIOUS SCENARIO	MAXIMUM SCENARIO
Total Potential (tons/year)	14,797	34,758
Currently being rescued from focal sectors, from within city boundaries (tons/year)	3,640 (2.7% of meal gap)	3,640 (2.7% of meal gap)
Untapped Potential (tons/year)	11,157	31,118
Untapped Meal Potential (meals/year)	18.6 million meals	51.9 million meals
Additional % of Meal Gap that could be met with untapped potential	8.3%	23.1%

The chart below unpacks these figures, highlighting opportunities across specific sectors, including the number of potential locations involved. The city's grocery sector represents just over 60 percent of the untapped potential under the ambitious scenario. Hospitality, healthcare and full-service restaurants also hold promise. We also noticed that donation potential measured on a per-location basis tends to be larger among institutions in NYC than similar institutions in Denver and Nashville, perhaps due to the larger average size of NYC healthcare facilities and universities, for instance. The possibility of relatively larger per-location pick-ups adds to the appeal of the institutional sector in NYC.

UNTAPPED POTENTIAL BY SECTOR FOR NEW YORK CITY (BEYOND AMOUNTS CURRENTLY BEING DONATED)

SECTOR	UNTAPPED POTENTIAL UNDER THE AMBITIOUS SCENARIO (TONS/YEAR)	LOCATIONS INCLUDED IN AMBITIOUS SCENARIO	UNTAPPED POTENTIAL UNDER THE MAXIMUM SCENARIO (TONS/YEAR)	LOCATIONS INCLUDED IN MAXIMUM SCENARIO
RETAIL GROCERY	6,769	436	9,371	545
HOSPITALITY	1,044	124	3,130	249
HEALTHCARE	959	108	2,876	216
UNIVERSITIES & COLLEGES	532	69	1,597	138
K-12	516	1,045	2,062	2,090
SMALL RETAIL/ CONVENIENCE STORES	265	96	2,381	646
CATERERS	140	229	422	459
COFFEE SHOPS	119	307	1,074	2,047
LIMITED SERVICE RESTAURANTS	93	485	1,132	3,235
TOTAL	**11,157**	**5,089**	**31,117**	**24,231**

While NYC has a long distance to go before pursuing the maximum scenario, it is worth noting that retail grocery continues to hold the greatest promise under that maximum scenario (with 30 percent of the untapped potential). Full service restaurants represent an additional 23 percent of the untapped potential. The remainder is split in much smaller increments among the remaining sectors.

Geographically across the five boroughs of NYC, the greatest density of potential donors is in Manhattan, particularly for restaurants. Grocery, small retail/ convenience stores and restaurants are especially prevalent in the denser urban areas where traffic, parking constraints and logistical considerations can be especially challenging for food rescuers. That said, considerable potential was identified in all five boroughs.

The possibility of relatively larger per-location pick-ups adds to the appeal of the institutional sector in New York City.

NASHVILLE

NASHVILLES UNTAPPED POTENTIAL PER YEAR

AMBITIOUS SCENARIO	MAXIMUM SCENARIO
2,088 TONS	5,566 TONS
3.5 MILLION MEALS	9.3 MILLION MEALS
18% OF MEAL GAP	48% OF MEAL GAP

TOP SECTORS

- Retail Grocery
- Healthcare
- Hospitality

The rapidly growing Metro Nashville area has a population of 657,000 with an estimated 16.4 percent of Nashvillians, or 107,750 people, considered food insecure (as of 2015). We identified more than 3,700 retail, restaurant and institutional foodservice locations there. Nearly 80 percent of these are either full-service or limited-service restaurants. Nashville's meal gap is estimated at more than 19 million meals per year, the equivalent of 11,597 tons of food.

Given existing donation efforts in the community, we identified annual donations from consumer-facing businesses within the Metro Nashville area of 1,210 tons, predominantly donations from grocery retailers to Nashville's foodbank.[50] Additional organizations engage in food rescue on a smaller scale, although infrastructure for rescuing prepared foods is currently more limited. Current donations from locations within Nashville that we could document (those sourced exclusively from our focal sectors for which data was available) are meeting just over 10 percent of Nashville's meal gap. This amount is complemented by food from other sources that is helping address the community's meal gap.

The maximum scenario suggests that more than 5,500 tons of additional food could potentially be available in the city's grocery, restaurant and institutional sectors

collectively per year, beyond current donations. Nashville could address an additional 48 percent of its meal gap from sources within the city if this level of food rescue could be achieved.

We estimate the potential for additional donations of 2,088 tons (nearly 4.2 million pounds) under the ambitious scenario, beyond current donations, as shown below. Reaching that level of food rescue would enable Nashville to address an additional 18 percent of its meal gap.

The chart on the next page highlights this potential across a variety of sectors and the number of locations from which these amounts could potentially be sourced. As in other cities, the grocery sector holds great promise for additional donations (beyond current levels), representing 70 percent of the untapped growth potential we see in Nashville.

MEAL GAP ANALYSIS FOR NASHVILLE		
Meal Gap (meals/year)	19.3 million meals	
Meal Gap (tons/year)	11,597 tons	
	AMBITIOUS SCENARIO	MAXIMUM SCENARIO
Total Potential (tons/year)	3,298	6,776 meals
Currently being rescued from focal sectors, from within city boundaries (tons/year)	1,210 (10.4% of meal gap)	1,210 (10.4% of meal gap)
Untapped Potential (tons/year)	2,088	5,566 million meals
Untapped Meal Potential (meals/year)	3.5 million meals	9.3 million meals
Additional % of Meal Gap that could be met with untapped potential	18.0%	48.0%

Healthcare and hospitality are also important sectors, representing potential for an additional 260 tons per year (combined) under the ambitious scenario. This amount is concentrated in just a few dozen locations. These two sectors account for more than 12 percent of the untapped potential under this scenario. The possibility of significant volumes of prepared foods at a modest number of locations should make them a priority for further development. While the amount of food appears to be more limited under our model, the same logic would apply to the university sector.

UNTAPPED POTENTIAL BY SECTOR FOR NASHVILLE (BEYOND AMOUNTS CURRENTLY BEING DONATED)

SECTOR	UNTAPPED POTENTIAL UNDER THE AMBITIOUS SCENARIO (TONS/YEAR)	LOCATIONS INCLUDED IN AMBITIOUS SCENARIO	UNTAPPED POTENTIAL UNDER THE MAXIMUM SCENARIO (TONS/YEAR)	LOCATIONS INCLUDED IN MAXIMUM SCENARIO
RETAIL GROCERY	1,466	58	2,136	73
HEALTHCARE	134	12	402	24
HOSPITALITY	126	29	377	59
FULL SERVICE RESTAURANTS	112	331	1,098	2,210
SMALL RETAIL/ CONVENIENCE STORES	83	22	741	153
UNIVERSITIES & COLLEGES	57	14	171	28
CATERERS	44	99	133	198
K-12	35	78	140	156
LIMITED SERVICE RESTAURANTS	28	117	340	780
COFFEE SHOPS	3	8	29	57
TOTAL	**2,088**	**768**	**5,567**	**3738**

Given the extent of the restaurant sector in Nashville, that sector has promise as well, with full-service restaurants showing 112 tons of untapped potential per year under the scenario, or just over 5 percent of the total. This food is spread across several hundred locations, though, presenting logistical challenges for rescuers. Innovations in rescue models and strategies like having restauranteurs freeze their donations (as is done by some of the best performers among national restaurant chains) could enable less-frequent, larger pickups. Convenience stores also merit heightened attention.

Geographically, the distribution of grocery locations in Nashville follows a "hub-and-spoke" geography, with most retail establishments located on major arterial roadways. Other potential donors, particularly in the hospitality sector, are concentrated in the city center and are less prevalent in the suburban and rural reaches of the city.

While the logistics of rescuing food in disparate ex-urban locations may be challenging, the concentration of potential donors in the city center is advantageous for rescuers. The potential for Nashville to meet an additional 18 percent of its meal gap through donations from within the city should motivate efforts to expand donations of both grocery items and prepared foods.

The potential for Nashville to meet an additional 18 percent of its meal gap through donations from within the city should motivate efforts to expand donations of both grocery items and prepared foods.

FOOD RESCUE AND THE REDUCTION OF DISCARDED FOOD

We also compared potential food rescue volumes with estimates of food discards in NRDC's baseline assessment. This comparison illuminates the potential role of food rescue in curbing the amount of food that goes uneaten. NRDC's baseline assessment found, for instance, that restaurants (limited and full service combined) account for 44 percent of the total food discards estimated collectively for the retail, restaurant and institutional foodservice sectors. Retail makes up 31 percent and institutions account for the balance.

We found that in the restaurant sector, just 2 percent to 3 percent of the total food discards estimated by NRDC could be avoided through donation even at the hypothetical rates reflected in our maximum scenario. Figures ranged from 5 percent to 10 percent among the hospitality, healthcare and universities/colleges sectors.

To a significant degree, these modest percentages reflect the very large portion of food discarded in these settings that is "post-consumer", such as plate waste, which is not suitable for donation. In fact, NRDC estimates that post-consumer discards may account for 65 percent to 90 percent of all food going unused in foodservice settings, based on dialogue with industry leaders. Pre-consumer discards, which occurs in commercial kitchens and involves food not yet served to customers, are much smaller by comparison. Many businesses are working to minimize their pre-consumer losses as this can reduce food purchasing costs and improves the bottom line. Once food has been sold and served to consumers, however, businesses have little incentive to reduce waste, particularly where the cost of landfilling is low.

By contrast, in the grocery sector, we estimate that more than one-third of the total volume of estimated food discards could potentially be donated under optimal conditions. In part, this reflects that nearly all food discarded from grocery stores is pre-consumer (e.g. it hasn't been served to customers given limited foodservice in most grocery contexts) and that much of it may be appropriate for human consumption if rescued promptly. For municipalities motivated to divert food from landfills, the grocery sector is a good place to focus. For businesses, food donation can generate valuable tax breaks and community goodwill, improve their environmental footprint by reducing landfilling, and provide modest reductions in disposal costs.

The K-12 School sector is something of a hybrid. Donation strategies such as "share tables" (where students can return unopened items like milk and whole fruits) can enable some post-consumer foods to be donated, where health regulations allow. In the K-12 sector, we found that roughly 16 percent of estimated total food discards could potentially be donated.

GREENHOUSE GAS EMISSIONS AVOIDED

When food is put into landfills, it generates methane, a powerful greenhouse gas (GHG) that is up to 86 times[51] more powerful than carbon dioxide. Indeed, 9 percent of the 176 million metric tons of GHG emissions associated with wasted food nationally are a result of uneaten food being landfilled.[52] By rescuing good food rather than landfilling it, cities can reduce their GHG emissions and advance their sustainability goals. We estimate that our focal cities could avoid the greenhouse gas emissions shown below by expanding their food rescue efforts. These figures reflect rescue of the "untapped potential" shown in our ambitious and maximum scenarios.

GREENHOUSE GAS EMISSIONS AVOIDED[53]

	AMBITIOUS (METRIC TONS OF CO_2e PER YEAR)	MAXIMUM (METRIC TONS OF CO_2e PER YEAR)
Denver	310	1,456
New York City	3,838	10,705
Nashville	718	1,915
TOTAL	**4,866**	**14,075**

This would avoid GHG equivalent to more than 11.6 million miles driven by passenger vehicles under the ambitious scenario and 33.7 million miles under the maximum scenario per year.[54] We also note that the remaining 91 percent of the greenhouse gas emissions associated with food that goes uneaten occur before food is disposed of, primarily during the food production phase as well as during transportation, processing, packaging, preparation, etc. As a result, cities and businesses alike are encouraged to make preventing food from being wasted in the first place their top priority. Prevention is where environmental benefits are maximized, and it is also where businesses, municipally funded foodservices and other food buyers stand to maximize cost savings. Where food cannot be used as originally intended, donation of appropriate foods is the best alternative.

It is also important to acknowledge that food rescue functions in themselves typically entail some level of GHG emissions. This occurs, for instance, when food is picked up and transported by vehicle from a donor to needy populations, potentially via one or more intermediary locations. Acknowledgement of associated emissions and efforts to minimize them are key, particularly where transportation of small amounts of food is involved.

Chapter 4: A Deep Dive—Denver Food Rescue Investment Analysis

Photo courtesy of MetroCaring

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In this final chapter, we assess some of the annual operating expenses and infrastructure investments that would be needed for Denver to rescue and distribute the amounts of food identified in our research. Our goal is both to acknowledge that food rescue isn't free (particularly at scale) and to illustrate how increased investment in rescue efforts could help Denver meet its meal gap.

For our analysis of food rescue investment needs, we:

- Conducted detailed interviews and data gathering with nine of an estimated 12 organizations in Denver that rescue food,
- Conducted an electronic survey with last-mile organizations that distribute food directly to needy individuals. 34 of 186 identified last-mile organizations participated in the survey, and
- Extrapolated from these organizations' existing operating costs and infrastructure to estimate needed budget and investments under the two scenarios.

Throughout this section of the report, we refer to rescue organizations as those that pickup food from donors and then transfer it to a centralized facility or deliver it directly to last-mile partner agencies. Last-mile organizations, such as food pantries and homeless shelters, are those that distribute food directly to people in need. Some organizations perform both functions. The costs outlined below would be in addition to costs now incurred by rescuers and reflect the incremental investments associated with heightened food rescue volumes.

DENVER'S FOOD RESCUE LANDSCAPE

We begin by setting the context with some of the patterns and characteristics of Denver's food rescue landscape.

Food Rescue Organizations

Denver-based food rescue organizations vary widely in their scale and approach. The largest organization surveyed, Foodbank of the Rockies, distributed nearly 30,000 tons of food in 2016 (from all sources including government commodities, amounts provided via the Feeding America network, food rescued locally, etc.) with a budget of more than $97 million per year.[55] The smallest in our study rescues 2.1 tons per year with no operating budget at all. Forty-four percent of the organizations reported having no paid staff, instead relying exclusively on volunteers. The typical rescue organization has 2.5 FTE paid staff. In fact, an estimated 79 percent of labor for rescue activity was reported as being provided by unpaid volunteers.

Most organizations rely on automobiles to transport food although a few have much larger vehicles including refrigerated trucks. All but one of the rescue organizations surveyed owns their own vehicles. One, Denver Food Rescue, primarily uses bicycles. Fifty-six percent of rescue organizations surveyed have some space for food storage or sorting. However, irrespective of organizational size, direct distribution (pickup and delivery to last-mile organizations without storing the food first) appears to be the preferred method for rescuing highly

perishable foods. Organizations of all sizes in Denver are experimenting with ways to minimize storage and time in transport between donor and receiver.

All organizations report that they attempt to optimize their routes by combining multiple pick-ups with multiple deliveries. Many noted that palletization of product (in large volumes) can be an impediment as it complicates efforts to deliver an appropriate mix of foods in appropriate quantities to individual, smaller organizations while en route.

Retail grocery is the most common source of donated food from sources located within Denver although significant volumes are also sourced from manufacturers and wholesalers. Food Recovery Network at the University of Denver and We Don't Waste handle prepared foods, although other prepared food rescue is limited. For most responding rescue organizations in Denver, fresh produce accounts for one-quarter to three-quarters of the food they rescue.

Forty-four percent of the organizations reported having no paid staff, instead relying exclusively on volunteers.

The primary costs for food rescue organizations were reported to be staffing, vehicles, and storage space. Given many smaller groups' heavy reliance on volunteers, the majority of Denver's rescue organizations have very modest annual budgets. The reported cost-per-pound of rescuing food varied greatly from 5 cents to 68 cents per pound based on reported annual operating expenses. Most organizations were in the 5 cent to 36 cent range, although this primarily reflects the cost of rescuing food from groceries, manufacturers and distributors, not more resource-intensive rescue from restaurants and institutions.

We also asked rescue organizations how much of the donated food they receive goes to waste while in their possession. **Forty-four percent of respondents said they don't track any food losses that may occur and 33 percent said they had no losses to report.** When reported, losses ranged from zero to 15 percent of food rescued, and as expected, are lowest for rescuers using a direct delivery model (although this may result in any losses being recognized at the last-mile level instead).

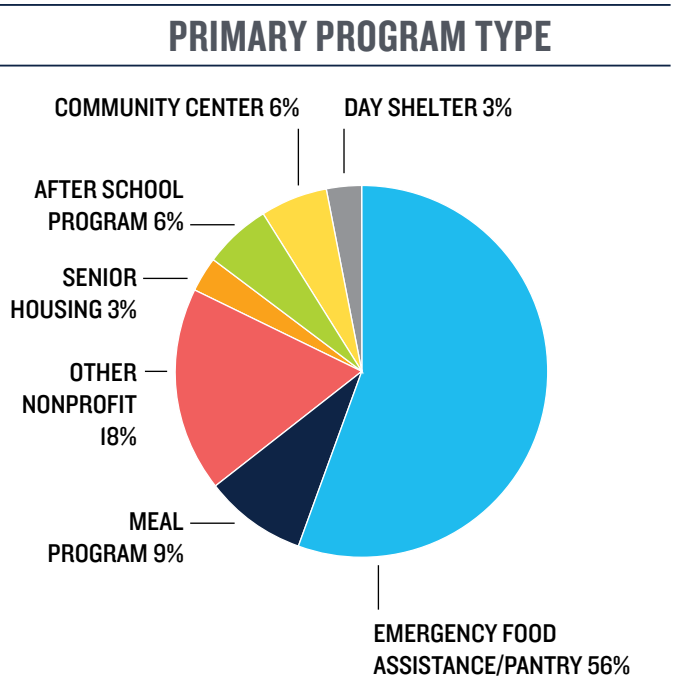
The resources identified as needed for growth were largely driven by organizational size. Generally, the smallest organizations, which tend to be most reliant on volunteers, desire funding for paid staff to coordinate volunteers and rescue logistics. Mid-sized organizations reported interest in having more vehicles and the budget to maintain them. Large organizations reported the strongest interest in expanded facilities to sort and store large volumes of product. As organizations move beyond meeting their basic needs, resources for longer hours of operation, additional programming and commercial kitchens may become a priority.

A common request voiced in our interviews was for improved coordination and training of donors, particularly grocers, with the goal of improving logistical efficiencies and increasing amounts donated. We believe this type of engagement with donors will be essential to achieving the levels of donation discussed in this report.

Last-mile Organizations

Among the 34 last-mile organizations that participated in the research:

- **Nearly 56 percent report that their "primary program" is providing emergency food assistance through a food pantry or similar distribution model.** As shown in the Figure below, others engage in a diversity of programs including after school programs, community centers, day shelters, senior housing and other on-site meal programs of various sorts.



- **Thirty-two percent of responding last-mile organizations are affiliated with a faith-based organization**, while the remainder are non-faith-based nonprofits.
- **Fifty-three percent of responding last-mile organizations operate without any paid staff**, relying entirely on volunteers.

- **Respondents report that, on average, 36 percent of the food they receive and distribute is fresh produce.** Organizations reported that just 11 percent of the food they receive is prepared ready-to-eat food, on average.
- **Fifty-six percent report that they did not have any food losses at their site or did not complete the survey question about discarded food.** Where food losses were reported, the most common reason was that the food's shelf-life was too short (identified by 47 percent of respondents). The second most common reason was food being of a type that wasn't desired by recipients (identified by 32 percent of respondents).
- **In terms of food quantities distributed, the mean level of food distributed (from all sources) was just under 400 pounds per week per location.** Collectively, respondents reported serving nearly 8,100 people per week. Scaling these figures up across all identified last-mile organizations suggests that roughly 32,000 people are being served per week. While this is a rough estimate and may double-count some individuals, this suggests that more than one-third of Denver's food insecure population may currently be reached each week.

INFRASTRUCTURE COST PROJECTIONS

Now we explore the financial costs associated with scaling up food rescue in Denver including annual operating expenses and infrastructure investments for vehicles and storage. We begin with several caveats.

As noted above, our model extrapolates from the existing costs reported by organizations participating in our survey. However, in the case of staffing, **we recognize that the supply of potential volunteers is not unlimited and can not necessarily be scaled up commensurate with food volumes.** Some roles will also require added skills as scale increases and the volume of perishables grows. Last-mile organizations can become better positioned for stability and programmatic scope when they can engage a larger share of their workers as paid employees.

As a result, we have calculated additional staffing costs on the assumption that volunteer labor would be paid at the current Colorado minimum wage ($9.30 per hour). We also note that Colorado's minimum wage is scheduled to rise to $12.00 per hour by 2020.[56]

Also, the costs reported by responding organizations largely reflect current rescue efforts in the grocery, wholesale/distribution and manufacturing sectors. Our figures are thus likely to be somewhat conservative when applied to food rescue from restaurants and institutions which may involve relatively greater logistics and cold storage needs. Our analysis of capital investment needs was limited to vehicles and storage. We did not attempt to estimate costs for commercial kitchens, other processing facilities, or other types of infrastructure.

Lastly, while some participating organizations may have capacity to handle additional food within their existing infrastructure, others are already constrained by existing limitations in their operating budgets and physical infrastructure. As a result, **our model may underestimate investments needed to optimize operational efficiency and effectiveness.** Our results should be interpreted as the minimum investments needed to meet basic organizational functions.

Our analysis yields the following annual operating expenses and capital investments. For the untapped potential under the ambitious scenario (901 tons), we estimate combined additional operating costs for rescue and last mile functions of nearly $2.0 million per year, with a minimum of $213,000 in near-term capital investments as shown below:

ESTIMATED OPERATING AND CAPITAL INVESTMENTS FOR THE UNTAPPED POTENTIAL UNDER THE AMBITIOUS SCENARIO

	RESCUE LEVEL	LAST MILE DISTRIBUTION LEVEL	COMBINED
ANNUAL OPERATING EXPENSES			
Volunteer labor if paid at minimum wage[57]	$214,717 (11.1 FTE)	$562,583 (29.0 FTE)	$777,300
Facilities rental[58]	$87,150 (including 10,215 sq ft of dry storage)	$108,679 (including 14,878 sq ft of dry storage)	$195,829
Other paid staff and operating expenses[59]	$400,114	$606,056	$1,006,170
TOTAL OPERATING COSTS/YR:	**$701,981**	**$1,277,318**	**$1,979,299**
NEAR-TERM CAPITAL INVESTMENTS			
Cold storage	$96,185[60] (1,839 sq ft)	$37,020[61] (1,234 cubic ft)	$133,205
Vehicles	$80,000[62] (2 vehicles)	$0	$80,000
MINIMUM CAPITAL INVESTMENTS:	**$176,185**	**$37,020**	**$213,205**

Under the maximum scenario, significant economies of scale become possible for rescue organizations. As shown below, our model suggests annual operating expenses of more than $1.6 million for rescue functions, with minimum near-term capital investments of just over $690,000 for cold storage and vehicles. At the last-mile level, our model suggests annual operating expenses of close to $4.6 million (again assuming volunteer labor at Colorado's current minimum wage) along with investments in cold storage of about $54,000.

As organization-owned vehicles are not commonly used for food pick up by last-mile organizations in Denver, we have not factored in vehicle costs here. However, greater transportation capacity could aid organizational efficiency at scale, particularly if a more employment-oriented approach is taken. This scenario yields combined annual operating costs of $6.2 million to rescue more than 4,200 additional tons of food and minimum near-term capital investments of $745,000 under the maximum scenario.

OPERATING AND CAPITAL INVESTMENTS FOR THE UNTAPPED POTENTIAL UNDER THE MAXIMUM SCENARIO

	RESCUE LEVEL	LAST MILE DISTRIBUTION	COMBINED
ANNUAL OPERATING EXPENSES			
Volunteer labor paid at minimum wage	$458,203 (23.7 FTE)	$2,545,194 (131 FTE)	$3,003,397
Facilities rental	$497,069 (including 62,411 sq ft of dry storage)	$214,074 (including space for 29,396 sq ft of dry storage)	$711,143
Other staff and operating expenses	$689,656	$1,793,710	$2,483,366
TOTAL OPERATING COSTS/YEAR:	**$1,644,928**	**$4,552,978**	**$6,197,906**
NEAR-TERM CAPITAL INVESTMENTS			
Cold Storage	$331,582 (6,339 sq ft)	$53,670 (1,789 cubic ft)	$385,252
Vehicles	$360,000 (9 vehicles)	$0	$360,000
MINIMUM CAPITAL INVESTMENTS:	**$691,582**	**$53,670**	**$745,252**

Cost per pound

We also looked at cost dynamics on a per-pound basis. Assuming volunteer labor is paid at the Colorado minimum wage, we estimate the following operating cost-per-pound of food (noting that current costs per pound are actually substantially lower due to the reliance on unpaid labor and other factors):

ESTIMATED ADDITIONAL OPERATING COSTS ON A PER-POUND BASIS

	AMBITIOUS SCENARIO	MAXIMUM SCENARIO
Tons of additional food per year	901	4,232
Food Rescue level (cost/lb)	$0.39	$0.19
Last Mile distribution (cost/lb)	$0.71	$0.55
TOTAL COST PER POUND	**$1.10**	**$0.74**

The figures at left highlight the potential economies of scale that can be achieved at the rescuer level, with estimated operating costs falling from 39 cents per pound to 19 cents per pound at higher food volumes. At the rescue level, logistics and storage can be more readily optimized with increased volume (for instance, through centralized facilities and larger vehicles). Increased capacity to rescue food at major events (such as cultural and sporting events) that generate large amounts of food in a single location during a brief period could heighten efficiency where prepared foods are concerned.

By contrast, we found potential economies of scale to be less pronounced at the last-mile level. The time and facilities associated with direct client interaction tend to increase in a more linear fashion relative to food quantities, particularly because many decentralized, smaller organizations are involved with distributing food directly to Denver's food insecure residents. Particularly at higher

For the untapped potential under the ambitious scenario (901 tons), we estimate combined additional operating costs for rescue and last-mile functions of nearly $2.0 million per year, with a minimum of $213,000 in near-term capital investments.

cost levels, food assistance organizations will need to consider trade-offs between the cost of providing donated food and purchasing food commercially. Innovations in rescue and distribution models, particularly those that involve more direct methods of distributing food from donors to needy individuals could help contain costs, as could building the base of available volunteers.

RECOMMENDATIONS FOR ACTION

Our analysis can provide direction for dialogue and action in Denver as it works to address food insecurity and keep good food from going to waste. These recommendations may also help inform efforts in other communities. The City and County of Denver, in particular, is encouraged to address the following recommendations:

- **Catalyze dialogue and multi-stakeholder planning:** It is clear from our analysis that Denver stands to benefit in multiple ways from strategically expanding the city's food rescue and distribution infrastructure. Our analysis and recommendations should be debated and honed by local stakeholders, synching them further with local aspirations and opportunities. The City and County of Denver is encouraged to:
  - Share this analysis with key stakeholders including policy makers and municipal staff, anti-hunger advocates, the business community, philanthropists and needy individuals;
  - Engage and convene stakeholders across these sectors and others as may be appropriate. Collaboratively identify shared interests in ramping up food rescue in line with local aspirations; and
  - Hone strategies for pursuing the opportunities identified in our research and others that may emerge from community dialogue.
- **Engage the food donor community:** None of this can succeed without the active engagement of food-related businesses and institutions. They are needed not only to donate surplus food, but to foster a culture of giving among their peers. They can also help by sharing their expertise on food distribution, processing, food safety and other key issues. Donors also enjoy community goodwill, tax breaks, reduced disposal costs and other benefits when they donate, but businesses that have not yet donated may be unaware of existing legal protections and these other benefits. The City, perhaps in conjunction with the Chamber of Commerce and area trade associations, can play a lead role in getting such information into the hands of prospective donors. The City and County of Denver is encouraged to:
  - Enlist food-related businesses and institutions as partners and co-strategists in crafting plans to expand Denver's food rescue landscape.

RECOMMENDATIONS

- CATALYZE DIALOGUE AND MULTI-STAKEHOLDER PLANNING
- ENGAGE THE FOOD DONOR COMMUNITY
- ENLIST CITY HEALTH INSPECTORS AS PART OF DENVER'S FOOD RESCUE TEAM
- IDENTIFY INNOVATIVE MODELS
- FINANCE SCALE AND INNOVATION FOR THE LONG-TERM
- INCORPORATE FINDINGS INTO THE DENVER FOOD PLAN

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- Provide information to businesses of all sizes about available tax incentives and liability protections for food donation, leveraging existing municipal outreach efforts where possible. The city should also consider how existing city regulatory functions, such as issuance of permits and inspections, could be used to inform businesses about the benefits of donating food.
- Collaborate to identify under-utilized infrastructure among area businesses, such as cold storage, commercial kitchens and vehicles, that could be leveraged to meet gaps in Denver's food rescue system.

- **Enlist city health inspectors as part of Denver's food rescue team:** City health inspectors bring a wealth of knowledge about food safety and are a vital asset in this work. Nevertheless, they may be unaware of the city government's interest in expanding food donation, particularly with more challenging items like prepared food. The city should mobilize its health inspectors to review relevant food safety regulations, streamline them where possible, and communicate them clearly to prospective donors. Guidance on safe food donation and encouragement to donate should be woven into health inspectors' visits to regulated food facilities and posted on the city's website.[63]
- **Identify innovative models:** New types of non-profit and for-profit rescue organizations and/or radically different rescue models may be needed to complement existing approaches if Denver is to achieve the scale of food rescue described here, particularly for prepared foods and other perishables. A review of innovative models from around the country, especially those focused on more challenging foods and innovative distribution models, can inform strategy development locally. Innovations in logistics and revenue generation may be particularly applicable to the challenges outlined in this research.[64]
- **Finance scale and innovation for the long-term:** A significant portion of the needed investment will be for on-going operating costs, not only vehicles and other physical infrastructure needs that are typically easier to fund. A competitive grant program, whether through philanthropic channels, corporate sponsorship, city government or a joint "opportunity fund", could amplify existing, successful non-profit and for-profit models while also cultivating new innovations. Multi-year grants are encouraged so that innovative approaches have time to stabilize and demonstrate their potential. Businesses that can receive tax breaks for their donations should be part of the discussion on financing food rescue infrastructure.
- **Incorporate findings into the Denver Food Plan:** The findings of this research should inform implementation of the Denver Food Vision (the city's long-term food strategic plan) and the Denver Food Action Plan 2020 (the city's short-term food action plan), particularly relative to food insecurity, food donation and reduction of greenhouse gas emissions. This should include the identification of benchmarks and evaluation tools to assess progress over time.

CONCLUSION

Our analysis is a first-of-its-kind effort to quantify the potential for multiple sectors of the food economy in Denver, New York and Nashville to expand food donations. Our data illustrates that expanded food rescue can play a greater role in meeting gaps in food availability in all three communities.

By putting a price tag on the financial investments that would be needed in Denver to make this possible, we hope to shed light on the true cost of rescuing and distributing donated food. Many of the recommendations above that pertain to our assessment of Denver's food rescue infrastructure can inform action in other cities. We hope that our learnings will foster dialogue by local stakeholders around the country, inspire additional cities to undertake similar analyses and enable more communities to keep more good food from going to waste.

Appendix A: Strengths and Limitations of Sector-specific Data Sources

SECTOR	CONFIDENCE LEVEL	DATA SOURCE	STRENGTHS	LIMITATIONS
RETAIL GROCERY	High	Feeding America, Annualized Donation Data from Supermarket Locations (2016)	Large sample size with detailed location-specific donation data spanning the entire nation	Large national grocers are over-represented, Data not available for independent grocers or rescuers other than Feeding America affiliated foodbanks. Will be less accurate when applied to food retailers with relatively larger sales of non-food items.
UNIVERSITY	Medium/High	Food Recovery Network, 2014-2016 Donation Data (2016), LeanPath, Institutional Food Service Pre-consumer Waste Measurements (2016)	Detailed donation data available along with documented pre-consumer discard data	Small sample size, Short duration study, Model parameters derived from aggregate statistics
SMALL RETAIL/ CONVENIENCE STORES	Medium	Food Donation Connection, 2015 Donation Data (2017)	Large sample size with high degree of spatial diversity including existing donation data	Model parameters derived from aggregate statistics, Existing donation rates may underestimate potential
RESTAURANTS (FULL- AND LIMITED-SERVICE)	Medium	Food Donation Connection, 2015-2016 Donation Data (2017)	Large sample size with high degree of spatial diversity including existing donation data	Model parameters derived from aggregate statistics, Existing donation rates may underestimate potential
COFFEE SHOPS	Medium	Food Donation Connection, 2015 Donation Data (2017)	Large sample size with high degree of spatial diversity including existing donation data	Model parameters derived from aggregate statistics, Existing donation rates may underestimate potential
HOSPITALITY	Medium/Low	LeanPath, Institutional Food Service Pre-consumer Waste Measurements (2016), Ana Carvalho, "Food Waste Composting as San Diego Hotels," BioCycle, January 2014	Innovative use of operational pre-consumer food discard measurements	Small sample size, short duration study, no data available on actual donations, Model parameters derived from aggregate statistics
HEALTHCARE	Medium/Low	LeanPath, Institutional Food Service Pre-consumer Waste Measurements (2016)	Innovative use of operational pre-consumer food discard measurements	Small sample size, Short duration study, no data available on actual donations, Model parameters derived from aggregate statistics
K-12	Low	Oakland Unified School District, Donation Data from Pilot Study (2016), St. Paul Public School District, Donation Data (2016) Hopkins (MN) Public School District, Donation Data (2016) Industry interviews	Combines observations from well-established and innovative rescue programs as well as industry expertise	Small number of districts, Limited data, Not spatially diverse
CATERERS	Low	No industry-specific data available	N/A	Based on proxy data from hospitality sector

Appendix B: Mathematical Formulae for Sector-specific Metrics

Our model uses the following mathematical formulae to estimate food rescue potential at the sector level. Data sources for each sector are specified in Appendix A.

RETAIL GROCERY

We used a donation rate defined as pounds donated-per-$100 of annual sales per location, using the 75th percentile pounds among current grocery retail donors based on actual donations from more than 19,300 chain grocery locations across the United States. As we did not have a way to disaggregate between sales of food and non-food items, we used total estimated sales per location. We applied a rate 0.53 pounds-donated-per-$100-of total sales, reflecting somewhat higher rates of donation in the regions where our cities are located relative to the nation-wide dataset. The 75th percentile for the entire national dataset was 0.45 pounds per $100. This donation rate is more than double the current median (50th percentile) rate. For the ambitious scenario we assume 80 percent of stores donate at this rate. For the maximum scenario we assume 100% of stores donate at this rate. The annualized rescue (AR) at location l in pounds can be calculated as:

$$AR_l = R_r * \left(\frac{S_l}{100}\right)$$

where

R_r is the donation rate

S_l is the annual store sales volume in dollars

RESTAURANTS, COFFEE SHOPS, AND SMALL RETAIL/CONVENIENCE STORES

Aggregate donation rates (in pounds per year by sector) were provided by Food Donation Connection based on anonymized, actual donations from a total of 6,130 locations in the restaurant sector (full-service and limited-service), coffee shops and convenience stores. Median, mean, and specific percentiles (75th, 90th) for each sector were provided as a basis for modeling. For coffee shops and small retail/convenience stores, percentiles were derived analytically from the mean and standard deviation using an assumption of normality. These figures were scaled using average per-sector sales figures to calculate donation rates per $100 of estimated annual sales per location.

We used reported mean, sample size, and standard deviation for each sector to calculate normal distribution percentiles of pounds donated per $100 sales. The 75th percentile was used for the ambitious scenario and the 90th percentile was used for maximum. The model based on convenience store data was applied to other food retailers with fewer than ten employees.

DONATION RATES (POUNDS PER $100 SALES PER YEAR)			
SECTOR	MEDIAN DONATION RATE	75TH PERCENTILE DONATION RATE	90TH PERCENTILE DONATION RATE
Full Service Restaurants	0.063	0.099	0.146
Limited Service Restaurants	0.032	0.070	0.128
Coffee Shops	0.072	0.136	0.183
Small Retail/Convenience Stores	0.700	0.943	1.135

The model used for all four sectors is:

$AR_l = \frac{S_l}{100} * R,$

where

S_l is the sales volume (in dollars per year) of location l

R is the donation rate in the table above

UNIVERSITIES AND COLLEGES

Our model uses pre-consumer food waste data documented through the LeanPath food waste tracking platform at seven universities during the initial two months after the LeanPath platform was instituted. The model used to estimate annual rescue potential for universities and colleges is:

$AR_l = M_l * R_{pc} * R_{ad} * R_{re} * R_{us},$

where

M_l is estimated number of meals served at location l.

$R_{pc} = 0.04$ pounds is the median pounds of pre-consumer food discards per meal served based on the LeanPath study

$R_{ad} =$ 1.2 is an adjustment factor to account for potential reduction in discards observed at locations participating in the study in the months immediately following introduction of the LeanPath tracking platform (estimated to be 20%)[65]

R_{re} = 0.56 is the fraction of pre-consumer food discards documented in the LeanPath study to be either overproduction or expired

R_{us} is a scaling factor for the amount of pre-consumer discards that may be usable in practice due to limitations in handling and logistics; we use $R_{us} = 0.5$ for the ambitious model (50%) and $R_{us} = 0.75$ (75%) for the maximum model.

Combining the constants results in a reduced model for the ambitious scenario:

$AR_{l(AG)} = M_l * 0.0124,$

and for maximum:

$AR_{l(AG)} = M_l * 0.0186$

The LeanPath data used in our analysis covered two months, which may include seasonal trends/variations for which we have not been able to correct. This is especially a concern in universities, which appear to have a substantial degree of seasonality due to the semester schedule. In a supporting analysis of existing donation at more than 200 colleges and universities from Food Recovery Network,[66] we found a statistically significant relationship between time of year and donation rates, with fall semester being the most productive time for donations, followed by spring, and finally summer. In that data, we also found that actual donations tend to be higher on a per-student basis at private colleges than public universities.

HOSPITALITY

Aggregated pre-consumer food waste data was obtained for two hotels using the LeanPath food waste tracking platform. To limit the effect that measurement efforts can have in spurring food waste prevention, we utilized data for the initial months after the LeanPath software was instituted. The model to estimate annual rescue potential at location l used for hotels is:

$$AR_l = W_l * R_{pc} * R_{re} * R_{us},$$

where

W_l is the estimated total food being discarded for location l in pounds (including pre- and post-consumer) (See NRDC baseline study.)

$R_{pc} = 0.15$ is the fraction of total discards assumed to be pre-consumer

R_{re} = 0.63 is the fraction of pre-consumer food discards documented to be either overproduction or "expired" through the LeanPath study

R_{us} is a scaling factor for the amount of discarded food that may be rescue-able in practice due to challenges with handling and logistics. We use $R_{us} = 0.5$ for the ambitious model (50%) and $R_{us} = 0.75$ (75%) for the maximum model

Combining the constants results in a streamlined model for the ambitious scenario:

$$AR_{l(AG)} = W_l * 0.0473$$

and for maximum:

$$AR_{l(AG)} = W_l * 0.0710,$$

which can be interpreted as 4.7 percent and 7.1 percent of the total food discards (including both pre- and post-consumer), respectively. We excluded hospitality businesses with fewer than 30 employees on the assumption that the supply of surplus food that could realistically be rescued from them is likely to be negligible.

HEALTH CARE

We utilized pre-consumer food waste data documented through the LeanPath food waste tracking platform at three hospitals over the course of the initial four months after the LeanPath software was instituted. This data was then applied to skilled nursing facilities as well. The model used for healthcare is:

$$AR_l = M_l * R_{pc} * R_{ad} * R_{re} * R_{us},$$

where

M_l is estimated number of meals served at location l

$R_{pc} = 0.11$ is the median pounds of pre-consumer food discards per meal served as derived from the LeanPath data.

$R_{ad} =$ 1.2 is an adjustment factor applied to per-meal pre-consumer discard rates to account for potential waste reduction at locations participating in the study in the months immediately following introduction of the tracking platform (estimated at 20 percent).

R_{re} = 0.75 is the fraction of pre-consumer food discard measured to be either over-production or "expired" at the LeanPath study of hospitals.

R_{us} is a scaling factor for the amount of discarded food that may be rescuable in practice due to limitations in handling and logistics. In this study we use $R_{us} = 0.5$ for the ambitious scenario (50 percent) and $R_{us} = 0.75$ for the maximum scenario (75 percent).

Combining the constants results in a reduced model for the ambitious scenario:

$$AR_{l(AG)} = M_l{*}0.0424,$$

and for maximum:

$$AR_{l(AG)} = M_l{*}0.0636,$$

K-12 SCHOOLS

Aggregated donation rates were provided by three school districts: Saint Paul (MN) School District, Hopkins (MN) School District, and Oakland (CA) Unified School District (OUSD).[67] The Saint Paul data includes donation data for one year, with Hopkins providing six months of data. The OUSD data includes detailed measurements of donation during an eight-day pilot program. These data have been augmented with interviews with school food service staff at these and other districts.[68] Based on this input, we assume 1.0 lb/student/year for the ambitious scenario and 4.0 lb/student/year for the maximum scenario:

$$AR_l = S_l{*}R,$$

where
S_l is the number of students at school l

R is the rate of expected donation measured in pounds per student per year, $R = 1$ for the ambitious scenario and $R = 4$ for maximum.

CATERERS

We were unable to obtain a reliable source of data for existing donations or surplus food that could potentially be rescued among (non-institutional) caterers. As a proxy, we used measurements of pre-consumer food discards gathered using the LeanPath software at a selection of hotels. The model used for caterers is:

$$AR_l = W_l * R_{pc} * R_{op} * R_{re} * R_{us},$$

where

W_l is the estimated total food being discarded (pre- and post-consumer) for location l in pounds. (See NRDC food waste baseline study.)

$R_{pc} = 0.15$ is the fraction of total discards assumed to be pre-consumer. For caterers, we use 0.15 (15%), which is supported by similar figures (16.5%) at a study of 6 hotels in San Diego, California.[69]

$R_{op} = 1.15$ is a scaling factor to account for 10 percent overproduction requirements that are often included in catering contracts and further overproduction to fully meet that requirement.

R_{re} = 0.44 is the fraction of pre-consumer food discards reported to have resulted from overproduction in the LeanPath study.

R_{us} is a scaling factor for the amount of discards that may be rescuable in practice due to limitations in handling and logistics. In our model we use $R_{us} = 0.5$ for the ambitious scenario (50 percent) and $R_{us} = 0.75$ (75 percent) for the maximum scenario.

Combining the constants results in a reduced model for the ambitious scenario:

$$AR_{l(AG)} = W_l * 0.0380$$

and for maximum:

$$AR_{l(AG)} = W_l * 0.057$$

which can be interpreted as 3.8 percent and 5.7 percent of total food discards, respectively.

Appendix C: Limitations and Future Research Needs

Our research was challenged by limitations in the availability and quality of underlying data and the boundaries of our research scope. Below we highlight areas where additional research could help fill key gaps.

QUANTIFICATION OF POTENTIALLY RESCUE-ABLE FOODS

- **Broader and deeper data for key sectors:** Research on additional sectors such as agriculture, food manufacturing and distribution, is needed to provide a more complete picture. Within the sectors we reviewed, the data available to us was particularly limited for the K-12 and catering sectors. National data on existing retail and restaurant donations outside of Feeding America and Food Donation Connection, respectively, is also limited. Grocery metrics could be strengthened by accounting more specifically for non-food sales. Inclusion of foodservice provided in business & industry contexts (such as corporate facilities), airports and event centers would bolster the institutional foodservice portion of the analysis. Fuller documentation of current rescue volumes in New York City would allow for more granular assessment of the remaining opportunity there.
- **Nutritional considerations:** Our research largely considered donated food by weight, not characteristics such as nutritional content or desirability to food insecure individuals or the organizations that serve them. Future studies should address these considerations to allow for better prioritization of food types and more strategic targeting of food rescue efforts.
- **Integration of socio-economic trends:** Our scenario analysis did not factor in broader socio-economic trends such as possible future changes in population, food prices, government policy, food rescue innovation, or the potential effect of waste prevention efforts on the supply of food that could be rescued. Future studies could usefully incorporate these considerations, as well as deeper assessment of losses that may occur after food is donated.
- **Spatiotemporal variation:** With few exceptions, we have not attempted to directly model or describe geographic variation in donation rates or how donation may change over time or as a function of seasons within the year. Models based on national donation data as a function of sales volumes may not appropriately account for differences in product costs across individual cities. Additional geographic-specific research could bolster this analysis.
- **Pre-consumer waste rates in institutional foodservice contexts:** The institutional food service data used in this study is primarily drawn from aggregated food waste measurements through the LeanPath platform at a small number of locations. Data from additional locations would make this data more robust. Assessing pre-consumer waste data over a longer period could shed light on how the supply of donatable food in institutional sectors may change as food waste prevention efforts gain traction. If similar pre-consumer waste tracking data becomes available for the restaurant sector, future research could apply our waste-based institutional model to restaurants, likely highlighting additional potential for donation.
- **Navigating data privacy concerns**: Data sensitivity concerns limited our ability to review and validate some underlying donation and pre-consumer waste data as we typically received statistics aggregated across an entire sector (rather than location-specific figures). Future studies may consider other approaches for obtaining data that allow greater transparency.
- **Greater validation of business informatics data:** Our underlying data on business locations in the three cities may have limitations in terms of its completeness or accuracy. Future studies may wish to integrate multiple sources of geographic data on food-related businesses.

DENVER FOOD RESCUE INVESTMENT ANALYSIS AND COST ESTIMATES

- **Generalizability:** Our estimate of investment needs in Denver is modeled on operational data from local organizations that participated in our research. Given the unique qualities of these organizations and the context in which they operate our cost model should not be generalized to other communities without additional validation and grounding in local circumstances. Additional research could explore costs using other rescue and distribution models than those currently being deployed in Denver.
- **Limitations in data availability:** The organizations participating in this research track their budgets and expenses in different ways. Many were unable to share data on items like the cost of vehicle maintenance, fuel and volunteer management costs, miles driven, and amounts of food that were rescued but later discarded. Data sensitivity and competitive concerns limited the availability of some types of data.
- **Potential for double counting:** Some donated foods pass through more than one organization (such as from a larger rescue organization to a smaller one), which leads to the potential for double-counting. Often, rescue organizations were not willing or able to share donor-specific figures. This prevented confirmation that reported amounts were rescued exclusively from within Denver and were not double counted.
- **Spatial normalization with the City of Denver:** We limited our study to organizations operating within the City of Denver although most of them rescue food from a broader geography. While we have tried to limit the data to Denver, our figures likely include some amounts sourced from outside of Denver. This would tend to overstate current amounts being rescued from within the City of Denver and understate the perceived potential for additional food rescue by a similar amount.
- **Comparability of sectors and geography:** The cost structures and infrastructure of Denver food rescue organizations reflect an amalgam of food sources and rescue models, some of which may be less resource intensive than the restaurant and institutional sectors included in our research. Also, some participating organizations are constrained by existing limitations in their operating budgets and physical infrastructure. As a result, our model may underestimate investments needed to optimize operational efficiency and effectiveness.
- **Duplication and competition among organizations:** Because these cost estimates consider aggregate pounds, they are projected as if all rescue in Denver was performed by a single organization. This will understate the duplication of effort and resources that may occur when multiple organizations pursue a similar donor base or offer overlapping services.
- **Inability to predict radical innovation:** It may be that radically different models are needed to achieve the level of food rescue described here. Our findings should be re-evaluated as new food rescue models emerge that may be fundamentally disruptive in their nature.

ENDNOTES

1 https://www.nrdc.org/sites/default/files/wasted-2017-report.pdf.

2 https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics/. Accessed September 25, 2017.

3 Gundersen, C., A. Dewey, A. Crumbaugh, M. Kato & E. Engelhard. *Map the Meal Gap 2017: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2015*. Feeding America, 2017. See http://map.feedingamerica.org/ for more information on Feeding America estimates of food needs at the county and state level across the country.

4 Darby Hoover, "Estimating Quantities and Types of Food Waste at the City Level," Natural Resources Defense Council (2017), available at https://www.nrdc.org/resources/food-matters-what-we-waste-and-how-we-can-expand-amount-food-we-rescue.

5 Ibid.

6 Martin C. Hellerand Gregory A. Keoleian, "Greenhouse Gas Emission Estimates of U.S. Dietary Choices and Food Loss," *Journal of Industrial Ecology*, 19:3 (4 September 2014) doi. 10.1111/jiec.12174. This study finds that the production of food lost at the retail and consumer level in the United States in 2010 contributed an additional 160 MMT CO_2e of GHG emissions https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics/. Accessed September 25, 2017. This estimate does not include GHG emissions from disposal, which we conservatively estimate to add another 16 MMT CO_2e by applying 2014 United States Environmental Protection Agency (EPA) estimates of food waste in landfills to the US EPA Waste Reduction Model (WARM). Together, these amount to 176 MMT CO_2e, which equates to 2.6 percent of the total US EPA GHG Inventory of 6873 MMT CO_2e.

7 https://www.nrdc.org/sites/default/files/wasted-2017-report.pdf.

8 https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security/#characteristics. Accessed September 25, 2017. Data as of 2016.

9 NRDC extrapolation based on http://map.feedingamerica.org. Accessed August 24, 2017.

10 Feeding America Map The Meal Gap One-Pager, 2015.

11 See Feeding America Map the Meal Gap One Pager. Feeding America's Map the Meal Gap initiative estimates "how many people, including children, are food insecure in every county and congressional district in the country. We also estimate how many are likely to qualify for federal nutrition assistance programs based on their incomes, how much money they report needing to buy just enough food, and how food prices vary from county to county... We use publicly available local data that research has shown to be associated with food insecurity, including unemployment and poverty, as well as homeownership and median income." Reported food budget shortfalls identified through surveys conducted by the Current Population Survey are translated into meal equivalents based on estimated average meal costs for each locale, yielding an estimate of the "meal gap" for that area. A "meal" is assumed to weigh 1.2 pounds.

12 http://www.feedingamerica.org/hunger-in-america/our-research/map-the-meal-gap/2015/2015-map-the-meal-gap-tech-brief.pdf.

13 Personal communications, Adam Dewey, Feeding America. Various May – August 2017.

14 Geovisualization and related user guide available at https://www.nrdc.org/resources/food-matters-what-we-waste-and-how-we-can-expand-amount-food-we-rescue.

15 Calculator tool and related user guidance is still in development before being made publicly available.

16 See https://www.naics.com/.

17 Meal gap data is not available at a geographic scale smaller than counties. As a result, we have used meal gap data for Davidson County, TN in our analysis for Nashville.

18 NRDC estimate based on confidential Feeding America database and personal communications with Kim Molnar, Second Harvest Foodbank of Middle Tennessee and Tallu Quinn, The Nashville Food Project (various 2017).

19 NRDC estimation. Approximately 17,000 restaurant locations (or roughly 1.7% of all U.S. restaurants) currently donate through the Food Donation Connection network, the largest organization working at a national scale to rescue prepared foods. Personal communications, Steve Dietz, Food Donation Connection with JoAnne Berkenkamp, various 2017.

20 National Restaurant Association www.restaurant.org.

21 NRDC estimate based on Regina Northouse, Food Recovery Network (various 2017), personal communications with JoAnne Berkenkamp and http://www.campuskitchens.org/locations/ (accessed July 21, 2017).

22 http://www.feedingamerica.org.

23 http://www.foodtodonate.com.

24 http://www.LeanPath.com.

25 Denver figures are based on surveys of Denver-based rescue organizations conducted by NRDC. See the Acknowledgements section of this report for a list of contributing organizations. Institutional donations are mainly from the university sector. Restaurant donations are primarily from full-service restaurants.

26 Rosanna Robbins, City Harvest (April 20, 2017) and Eric Davis, Feeding America (various March 2017), personal communications with JoAnne Berkenkamp.

27 Kim Molnar, Second Harvest Foodbank of Middle Tennessee (various 2017) and Booth Jewett, The Nashville Food Project (March 9, 2017), personal communications with JoAnne Berkenkamp.

28 USDA, "What We Eat In America," Agriculture Research Service, 2014.

29 Eric Davis, Feeding America, personal communications, various November 2016 to May 2017.

30 *Progressive Grocer*, July 2015. http://magazine.progressivegrocer.com/i/541526-jul-2015.

31 Given the data available to us, our model uses retail sales data that encompass sales of both food and non-food items. In parallel, modest amounts of non-food items are also reflected in Feeding America donation data. Given the prevalence of non-food items in many retail grocery contexts, our pounds-per-$100-sales metric would likely be somewhat higher if measured exclusively relative to food sales.

32 Steve Dietz and Keith Crowe, Food Donation Connection, personal communications, various January 2016 – May 2017.

33 https://chdexpert.wordpress.com/2012/08/03/full-service-restaurants-vs-limited-service-restaurants-whats-the-difference/, accessed July 2, 2017.

34 Analysis conducted by Food Donation Connection to preserve donor confidentiality, based on per-location sales data from Nation's Restaurant News: *"Top 100"*, 2016.

35 NRDC estimation. Approximately 17,000 restaurant locations, or roughly 1.7 percent of U.S. restaurants, currently donate through the Food Donation Connection network, the largest organization working at a national scale to rescue prepared foods.

36 National Restaurant Association www.restaurant.org.

37 www.leanpathLeanpath.com.

38 Andrew Shakman and Brennan Hogan, LeanPath, personal communications with JoAnne Berkenkamp, various dates March 2016 to April 2017.

39 Andrew Shakman and Brennan Hogan, LeanPath, personal communications with JoAnne Berkenkamp, March 22, 2017.

40 Regina Northouse and Hannah Cather, Food Recovery Network, personal communications, October 2016 to June 2017. https://www.foodrecoverynetwork.org/.

41 Hoover, 2017 & geovisualisation tool.

42 Brennan Hogan, LeanPath, personal communication with JoAnne Berkenkamp, October 21, 2016.

43 For comparison, a study of six hotels in San Diego, CA found pre-consumer food waste rates of 16.5% of total food waste. *"Food Waste Composting at San Diego Hotels",* Ana Carvalho, BioCycle, January 2014.

44 Oakland (CA) Unified Public School District, St. Paul (MN) Public School District and Hopkins (MN) Public School District.

45 Nancy Deming, Oakland Public Schools, Jean Ronnei, Pro-Team Foodservice Advisors and Past President, School Nutrition Association, Barb Mechura, Hopkins Public Schools, Bertrand Weber, Minneapolis Public Schools and Stacy Koppen, St. Paul Public Schools, personal communications with JoAnne Berkenkamp, January – March 2017.

46 Steve Dietz and Keith Crowe, Food Donation Connection, personal communications, various January 2016 – May 2017.

47 https://chdexpert.wordpress.com/2012/08/03/full-service-restaurants-vs-limited-service-restaurants-whats-the-difference/, accessed July 2, 2017.

48 Personal communications with JoAnne Berkenkamp, Eric Davis, Feeding America, February 9, 2017.

49 Rosanna Robbins, City Harvest (April 20, 2017) and Eric Davis, Feeding America (various March 2017), personal communications with JoAnne Berkenkamp.

50 For more information on, see http://secondharvestmidtn.org/. Kim Molnar, Second Harvest Food Bank of Middle Tennessee, and Tallu Quinn, The Nashville Food Project, personal communications with JoAnne Berkenkamp, various 2017.

51 International Panel on Climate Change, *Fifth Assessment Report*, (2013) Table 8.7. Methane packs 36 times the heat-trapping punch of carbon dioxide, pound-for-pound, over the course of a century after it is released. However, over a shorter period of 20 years, non-fossil methane is 86 times more powerful than carbon dioxide.

52 Martin C.Hellerand Gregory A. Keoleian, "Greenhouse Gas Emission Estimates of U.S. Dietary Choices and Food Loss," *Journal of Industrial Ecology*, 19:3 (4 September 2014) doi. 10.1111/jiec.12174. This study finds that the production of food lost at the retail and consumer level in the United States in 2010 contributed an additional 160 MMT CO_2e of GHG emissions. This estimate does not include GHG emissions from disposal, which we conservatively estimate to add another 16 MMT CO_2e by applying 2014 United States Environmental Protection Agency (EPA) estimates of food waste in landfills to the US EPA Waste Reduction Model (WARM). Together, these amount to 176 MMT CO_2e, which equates to 2.6 percent of the total US EPA GHG Inventory of 6873 MMT CO_2e.

53 Estimations based on Environmental Protection Agency, The Waste Reduction Model (WARM), March 2016. See also https://www.epa.gov/warm/guidance-how-use-materials-and-management-pathways-not-found-waste-reduction-model-warm.

54 NRDC estimate based on https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator, accessed August 22, 2017.

55 http://fbr.convio.net/site/DocServer/2016_Annual_Report.pdf?docID=6283. Accessed August 15, 2017.

56 https://ballotpedia.org/Colorado_$12_Minimum_Wage,_Amendment_70_(2016), accessed July 17, 2017.

57 Staffing costs reflect the assumption that all volunteer labor is paid at the current Colorado minimum wage of $9.30/hr.

58 Facilities rental costs encompass cold and dry storage, space to distribute more food to needy individuals and expanded commercial kitchen space, where applicable, extrapolating from current facilities reported by responding organizations. We did not have adequate data to factor in potential investments in kitchen equipment for last-mile organizations that prepare ready-to-eat meals.

59 Other Operating Costs are based on reported expenses by Denver rescue and last-mile organizations. They may include other staffing, outreach costs, utilities, administrative fees paid by Last Mile groups to rescuers where applicable, packaging, office supplies, expendable equipment and other sundry costs.

60 Cold storage at rescue level: we assume that rescuer organizations will use walk-in coolers, using an average cost figure of $52.30 per square foot based on a quote provided by Tundra Specialties (C. Phillips, 2017). (Note that rescue organizations in our study preferred to reference cold storage in square feet, while last-mile organizations referenced cubic feet.)

61 Cold storage at last-mile level: we assume that last-mile organizations are more likely to use residential-size refrigerator/freezers rather than commercial walk-in coolers. We assume a cost of $30 per cubic feet of cold storage, which assumes that organizations utilize a combination of new and used equipment. Common costs for new residential units are $40 to $53 per cubic foot.

62 Potential vehicle costs vary greatly depending on the size and type of vehicle, whether it is refrigerated, and whether it is purchased new or used. Given that institutions and restaurants represent a significant portion of untapped potential, we assume that smaller Class 1 vehicles will be appropriate in many cases. We assume an average cost of $40,000 per vehicle. Costs will be higher for larger refrigerated vehicles.

63 For an example of this approach, see NRDC's case study on Waste Not Orange County, available at https://www.nrdc.org/resources/food-matters-what-we-waste-and-how-we-can-expand-amount-food-we-rescue.

64 For examples, see NRDC's case studies on Second Harvest Heartland of Middle Tennessee, Daily Table, Waste Not Orange County, DC Central Kitchen and Drexel Food Lab, available at https://www.nrdc.org/resources/food-matters-what-we-waste-and-how-we-can-expand-amount-food-we-rescue.

65 Andrew Shakman, LeanPath, personal communications with JoAnne Berkenkamp. Various dates March 2016 to April 2017.

66 Regina Northouse and Hannah Cather, Food Recovery Network, personal communication with JoAnne Berkenkamp, various 2016 – 2017.

67 Oakland (CA) Unified Public School District, St. Paul (MN) Public School District and Hopkins (MN) Public School District.

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69 Carvalho, *BioCycle*.