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Working Paper

Arizona State Freight Plan

(ADOT MPD 085-14)

Phase 3 Working Paper
Food and Beverage Sector Profile and Transportation Performance Needs

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Solutions for growing economies

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This working paper is one of 10 focusing on key Arizona economic sectors. Its purpose is to document the economic profile, outlook and transportation performance needs of Arizona's food and beverage sector. This working paper will later inform system improvement needs to increase Arizona's economic competitiveness and growth. This working paper is provided for comment and discussion and should not be interpreted as final.

Acknowledgements

The CPCS team would like to thank the Arizona Department of Transportation (ADOT) for its guidance and input in developing this working paper. The team also recognizes the considerable contribution of the food and beverage stakeholders consulted in the development of this working paper.

Opinions

Unless otherwise indicated, the opinions herein are those of the author and do not necessarily reflect the views of ADOT or the State of Arizona.

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Table of Contents

Executive Summary

Economic and Traffic Profile

The food and beverage sector includes dairy product manufacturing, bakery product and tortilla manufacturing, beverage manufacturing, food transportation and distribution, and food service (e.g. restaurants and bars).

Overall, the sector contributed $8.1 billion to the State's gross domestic product (GDP) in 2012, representing three percent of the State's total economic output. Food and beverage manufacturing is concentrated around the I-10 corridor in Phoenix. Restaurants and bars are clustered around urban areas with high populations.

	Measure	Food and Beverage Sector	Arizona (Statewide)
Economy	GDP (2012, $ million)	$8,142	$271,503
	GDP Annualized Growth (1997-2012)	6.1%	4.9%
Jobs	Employment (2013)	212,004	2,619,055
	Compensation per Employee (2013)	$23,135	$57,393
Transportation	Total Commodity Flows (2012, Mt)	10.5	138.2
	Top Origin (2012, Mt)	California (2.4 Mt)	California (9.5 Mt)
	Top Domestic Destination (2012, Mt)	California (1.2 Mt)	Mexico (5.6 Mt)
	Intrastate Flows (2012, Mt)	2.9	101.8
	% Truck (2012)	96.2%	87.2%

Source: CPCS analysis of data from Bureau of Economic Analysis and 2012 Commodity Flow Survey

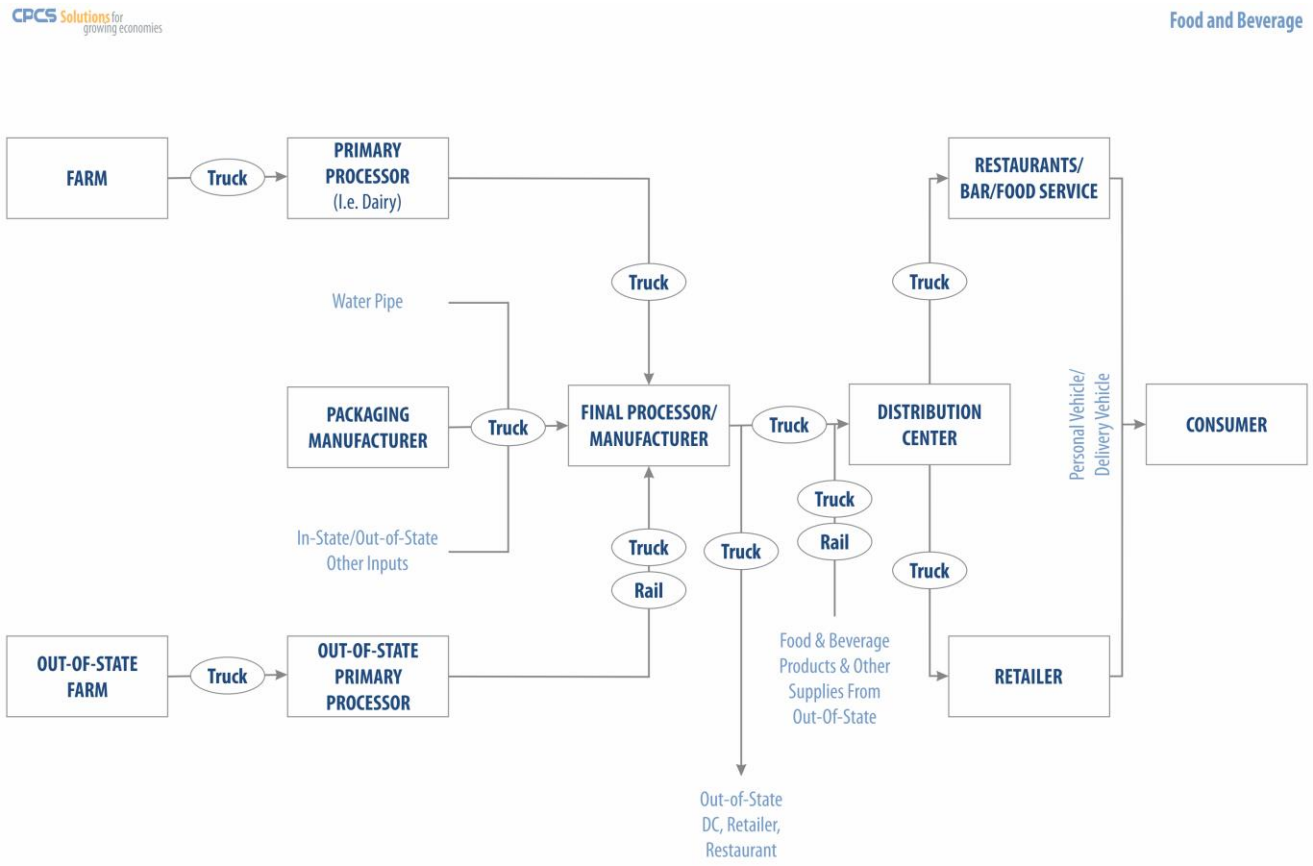
Most food and beverage products are shipped within the state or to or from adjacent states. California was the largest origin and destination of food and beverage products from or destined to Arizona. Most inbound and outbound food and beverage products are transported by truck, with the exception of some inbound products which are transported by rail. This breakdown is in line with expectations that, with the exception of some less-perishable products (e.g. corn for tortilla manufacturing, beer), most products must be delivered by trucks as the products are (1) perishable, (2) being transported a relatively short distance (e.g. to or from California, or intrastate), and/or (3) being transported to a non-rail served customer base (e.g. restaurants).

Supply Chain Structure and Transportation Performance Needs

Figure ES-1 shows a typical food supply chain from farm to customer. Agricultural inputs for food manufacturing often first goes through a primary processing plant. For example, corn is processed into corn meal for tortilla and chip making, canola and other oil seeds are processed into oil for frying, and livestock is slaughtered and butchered for use in other

products (such as hot dogs, sausage, burgers, etc.). These agricultural inputs, along with other inputs (notably packaging), are then transported to final manufacturing plants mainly by truck, sometimes by rail, and occasionally pipeline.[1] At the manufacturing plant, the inputs are processed into various products. In the case of Arizona, finished products include packaged beef, dairy products (e.g. cheese and yogurts), tortillas, and other bakery products, among others. These products are then transported to wholesalers, food distributors, restaurants, bars, and other locations serving food.

Figure ES-1: Typical Food Supply Chain



Source: CPCS, adapted initially from: Matopoulos, A., et al. "A conceptual framework for supply chain collaboration: empirical evidence from the agri-food industry." *Supply Chain Management: an international journal* 12.3 (2007): 177-186. The figure was further developed based on the results from stakeholder consultations, the data presented in Chapter 2, and information from other sources, such as NCFRP Report 14: "Guidebook for Understanding Urban Goods Movement."

Food and beverage sector shippers are concerned about transportation costs, but, given that spoilage must be avoided for many products, travel time is of greater concern. Reliability is also a concern, though the needs of each subsector, each business, and even each product can vary significantly. For example, a casual dining restaurant may have ample room to hold inventory, whereas a quick-serve or high volume restaurant may require regular deliveries. In particular, some high-volume restaurants will require an early morning delivery of certain

[1] E.g. water from the municipal system for beverage production.

products to allow time for unpacking and preparation before the lunchtime rush. On the manufacturing side, generally speaking, more reliability is required for more perishable products, and vice-versa.

Ensuring adequate (refrigerated) trucking capacity throughout the entire year is a concern of some stakeholders in Arizona. There is a high demand for outbound refrigerated trucking capacity in the winter and spring as a result of the Arizona produce harvest season, and accordingly, there tends to be a shortage of trucks during this period. One stakeholder noted that his company often selects trucking companies based on the assurance that they will transport products throughout the year.

Notable Barriers and Related Priority Improvements to Enhance Competitiveness and Growth

A key economic development issue within the food and beverage industry is the extent the operations act as a base (or export) sector and import dollars into the state. Basic agriculture harvesting and transport represents the lowest level in the value chain, followed by food and beverage processing, then eventually into chemical and pharmaceutical production under the right economic conditions. Even though food and beverage activities can be largely population driven, local production or storage for use out of the state still contributes to the state's economy. A quality transportation network can help to make the current status of the industry more efficient and profitable, and also open the door for added value operations that may benefit the state over the longer term.

Most stakeholders were concerned about regulatory issues affecting the performance and cost of truck transportation, rather than with infrastructure. However, congestion, in particular on the I-10, and ensuring a state of good repair were two infrastructure concerns highlighted.

The key issues raised by stakeholders related to availability of truck transportation services and the cost implications of a lack of availability. Notably, shippers and carriers expressed concern regarding:

- a shortage of drivers, and how increasingly stringent regulatory requirements (e.g. hours of service) exacerbate the shortage; and
- truck engine emissions regulations, particularly in California (these requirements particularly affect the food and beverage sector as there are requirements that apply not only to the truck engines themselves, but also the engine that generates power for refrigerated vehicles and trailers).

Acronyms and Abbreviations

ACA	ARIZONA COMMERCE AUTHORITY
ADOT	ARIZONA DEPARTMENT OF TRANSPORTATION
CARB	CALIFORNIA AIR RESOURCE BOARD
CDL	COMMERCIAL DRIVERS LICENSE
CFS	COMMODITY FLOW SURVEY
CNG	COMPRESSED NATURAL GAS
FHWA	FEDERAL HIGHWAYS ADMINISTRATION
°F	DEGREES FARENHEIT
GDP	GROSS DOMESTIC PRODUCT
MAP-21	MOVING AHEAD FOR PROGRESS IN THE 21ST CENTURY ACT
MPD	MULTIMODAL PLANNING DIVISION (OF ADOT)
NCFRP	NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM
U.S.	UNITED STATES

1 Introduction

Key Messages

The Arizona Department of Transportation, Multimodal Planning Division, retained a team led by CPCS Transcom, Inc. to assist in the development of Arizona's State Freight Plan.

The aim of this working paper is to establish the freight transportation performance needs, outlooks, and economic contribution of Arizona's food and beverage sector (defined here as NAICS Codes 311, 312 and 722). This will later inform the analysis of broader transportation system based needs and priorities.

This working paper was developed in large part through stakeholder consultations and analysis of the food and beverage sector data.

1.1 Introduction: Why an Arizona State Freight Plan?

Arizona's economic potential is supported by the state's transportation infrastructure, which connects sources of production to markets.

When transportation infrastructure and related services are efficiently designed and competitively positioned, businesses benefit from lower transportation costs, faster and better transportation services, and increased reliability, which in turn contribute to their own competitiveness and growth, and that of the broader region.

Jurisdictions with access to competitive transportation infrastructure and services are at a competitive advantage in attracting investment, creating jobs and realizing economic growth. Arizona's State Freight Plan can help enable this outcome.

To this end, the ADOT's Multimodal Planning Division (MPD), is developing Arizona's State Freight Plan which will provide strategic guidance to enhance Arizona's economic competitiveness and facilitate economic growth.

1.2 Project Objectives

The State Freight Plan will define immediate and long-range investment priorities and policies that will generate the greatest return for Arizona's economy, while also advancing other key transportation system goals, including national goals outlined in MAP-21. It will identify freight transportation facilities in Arizona that are critical to the State's economic growth and give appropriate priority to investments in such facilities.

The State Freight Plan will ultimately provide Arizona with a guide for assessing and making sound investment and policy decisions that will yield outcomes consistent with the state's visions, goals, and objectives, and notably, promote regional competitiveness and economic growth.

1.3 Purpose of this Working Paper

Since it is economic activity – particularly from goods movement sectors - that drives demand for freight transportation infrastructure and services, optimization of the state's freight transportation system, and related strategies, goals and investments, must start by addressing the transportation performance needs of the sectors moving freight. Yet, the transportation

performance needs of freight can differ by sector and commodity group, locations and even company.

For this reason, the team identified 10 key freight sectors in Arizona for specific focus: wholesalers and retailers, food and beverage, high-tech manufacturing, general manufacturing, transportation equipment manufacturing, transportation and logistics, mining (except oil and gas), energy (oil and gas), agriculture, and forestry.

The purpose of this working paper is to provide a focused assessment of the transportation performance needs, outlooks and economic contribution of the food and beverage sector (defined here as NAICS Codes 311, 312 and 722).

Specifically, it addresses the following key questions:

- At a high level, what is the profile and economic contribution of the food and beverage sector to Arizona's economy?
- How do the supply chains of Arizona's food and beverage sector utilize the transportation system and what are the major origins, destinations, intermediate points, and final products of these chains?
- How are food and beverage sector supply chains structured, managed, and what are the primary drivers of transportation decisions and related performance needs?
- What are the key trends in the food and beverage sector, how are these influencing freight flows, and what are the implications, opportunities and challenges for the competitiveness of Arizona's freight system going forward?

1.4 Methodology

This working paper is informed by a combination of literature review, data collection and analysis, and consultation with food and beverage sector stakeholders. With the exception of stakeholders at Frito-Lay and the Port of Tucson, most stakeholders did not wish to have their comments attributed.

1.5 Limitations

This working paper is in many cases informed by data and input provided by third parties. CPCS has verified this information to the extent possible through analysis and cross-checking with other sources but cannot guarantee the accuracy of data received from third parties.

2 Food and Beverage Sector Profile

Key Messages

- **Overview:** The food and beverage sector includes the following subsectors: meat manufacturing, dairy product manufacturing, bakery product and tortilla manufacturing, beverage manufacturing, food transportation and distribution, and food service.
- **Economic impact:** The food and beverage sector in Arizona contributed $8.1 billion to the State's gross domestic product in 2012, representing three percent of the State's total economic output. Since 1997, GDP in the food and beverage sector has grown at a rate of 6.1 percent per annum, over performing compared to the overall state average of 4.9 percent GDP growth per annum.
- **Employment cluster:** Food and beverage manufacturing businesses are concentrated around the I-10 corridor in Phoenix. Restaurants and bars are clustered around urban areas with high populations.
- **Major Origins and Destinations:** California was the largest origin and destination of food and beverage products from or destined to Arizona
- **Modes used:** Most inbound and outbound food and beverage products are transported by truck, with the exception of some inbound products which are transported by rail

2.1 Overview of the Food and Beverage Sector

The food and beverage sector, as defined, consists of food and beverage manufacturing, along with food services and drinking places.

Food and beverage manufacturing consists of turning raw agricultural inputs into products that can be delivered to wholesalers, retailers, and food service establishments (e.g. restaurants). Specifically, in Arizona, food and beverage manufacturing consists of dairy product manufacturing, meat product manufacturing, bakeries and tortilla manufacturing, and beverage manufacturing. For example, in the case of dairy manufacturing, milk provided by dairy producers is processed into products such as cheese, yogurt, ice cream, etc. and packaged for delivery. As such, these subsectors are closely related to the agricultural sector (upstream) and wholesaler and retail sectors (downstream), which are addressed in separate economic sector working papers.

Food services and drinking places (e.g. restaurants and bars) are downstream of food and beverage manufacturers. Food service distributors link manufacturers to restaurants and bars, by storing products received from food manufacturers, repackaging them as required, and distributing them to restaurants and bars. This supporting subsector may be classified under the transportation and logistics sector (covered under a separate economic sector working paper), but serves an important supporting function in this industry.

Major food and beverage companies in Arizona include:

- **Meat manufacturing:** JBS, Bar-S Foods, Red Bird Farms, Prime Cut Meat and Seafood Company, Denmark Foods;
- **Dairy product manufacturing:** United Dairymen of Arizona, Shamrock Foods, Franklin Foods, Safeway, Daisy Brand;
- **Bakery product and tortilla manufacturing:** Grupo Bimbo operations, R&S Mexican Food Products, La Canasta Mexican Foods, Frito-Lay (PepsiCo), UC Bakery;
- **Beverage Manufacturing:** Coca-Cola Bottling, PepsiCo Bottling and Gatorade Manufacturing, Kalil Bottling;
- **Food transportation and distribution:** Sysco, US Foods, GAMPAC, McLanes Food Service;
- **Food service:** Various outlets, with the largest chains including Starbucks and McDonald's;
- **Other:** Nestle Purina Pet Food; etc.[2]

[2] List based on various sources.

2.2 Economic Profile and Importance to Arizona's Economy

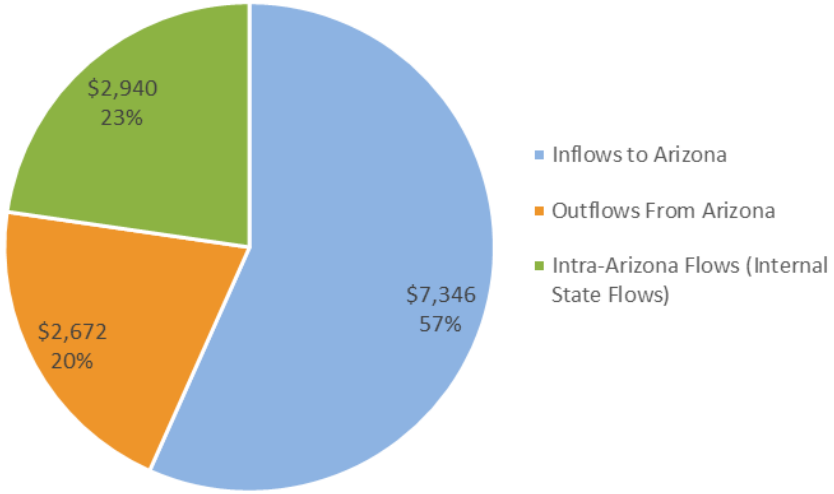
2.2.1 GDP

The food and beverage sector[3] in Arizona contributed $8.1 billion to the State's GDP in 2012, representing three percent of the State's total economic output. Of this, $1.7 billion was related to the production and manufacturing of food and beverage products and the remaining $6.5 billion in the food services and drinking places downstream industry. Since 1997, GDP of the food and beverage sector has grown at a rate of 6.1 percent per annum, faster than the overall state average of 4.9 percent per annum.[4]

2.2.2 Commodity Flows

Overall, $13 billion of goods in the food and beverage sector travelled into, out of, or within Arizona in 2012. Of this, $7.3 billion of goods originated in other states and were destined to Arizona, $2.7 billion originated in Arizona and were destined to other states, and $2.9 billion in goods travelled within the state of Arizona.

Figure 2-1: Value of Flows Into, out of, and Within Arizona in 2012 ($millions)



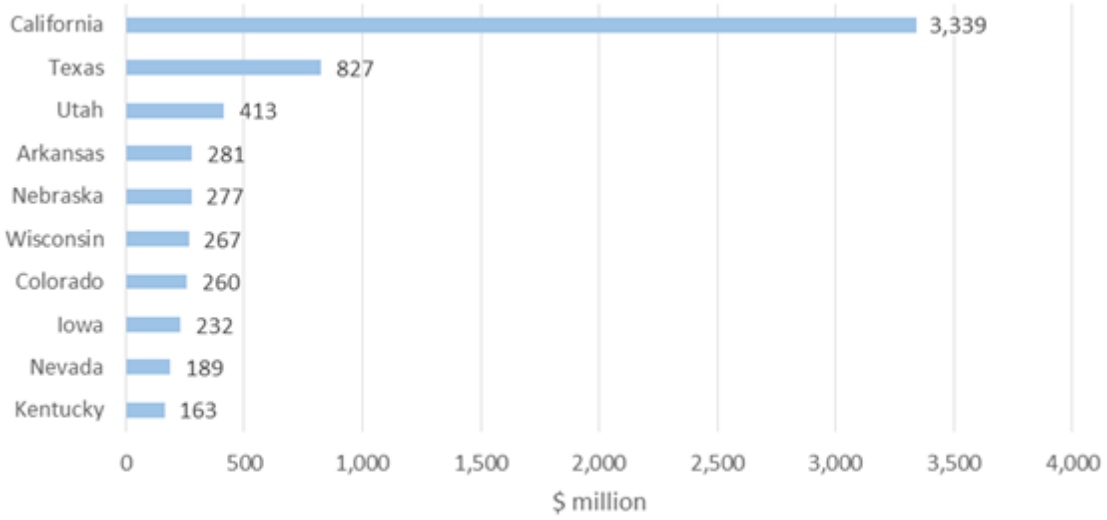
Source: CPCS analysis of Commodity Flow Survey, 2012.

2.2.3 Origins of Inflows to Arizona from Other States

The figure below summarizes the origins of food and beverage sector products that were shipped to Arizona from other states. California was the largest origin of food and beverage products destined for Arizona with $3.3 billion of products, followed by Texas and Utah at $827 million and $413 million respectively.

[3] All numbers in this section exclude the retail component of the food and beverage business, and are related to food and beverage production and manufacturing only. Retail numbers are included in the retail and wholesale sector.
[4] Bureau of Economic Analysis Regional Economic Accounts, GDP by State. GDP in current dollars.

Figure 2-2: Value of Top 10 Food and Beverage Sector Inflows to Arizona by State or Origin (2012)

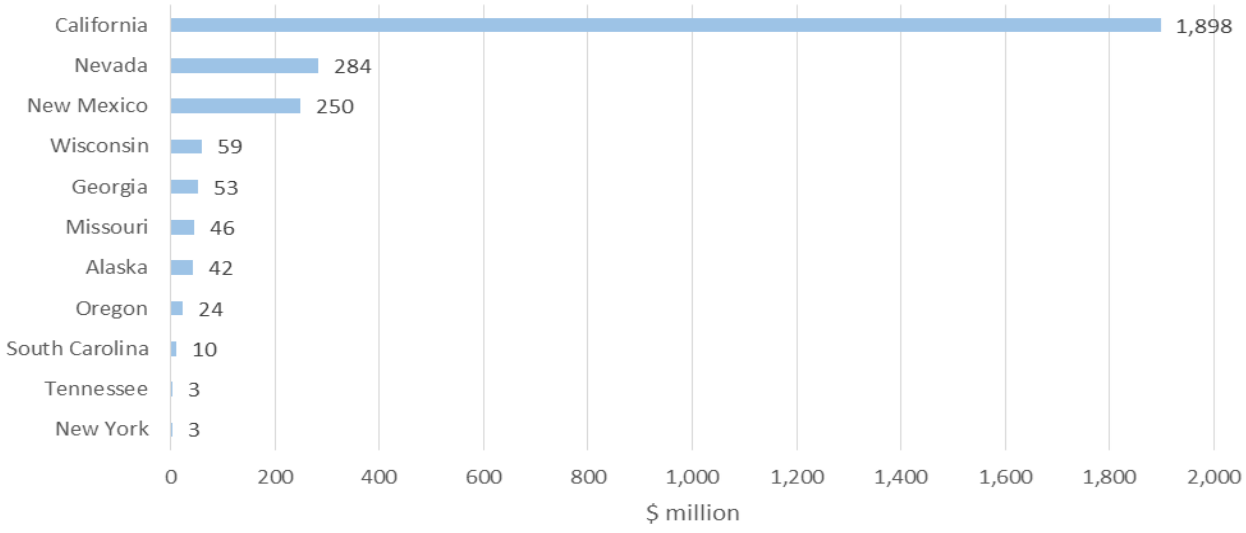


Source: CPCS analysis of Commodity Flow Survey, 2012.

2.2.4 Destinations of Outflows From Arizona to Other States

The figure below summarizes the destination of food and beverage products originating in Arizona and transported to other states. California was the largest destination of Arizonan food and beverage products, where $1.9 billion worth of products originating in Arizona were destined. Some of these flows may have been subsequently destined for international destinations through ports located in California. A review of international trade flows to and from Arizona is contained in Section 2.2.5.

Figure 2-3: Value of Food and Beverage Outflows from Arizona by State of Destination (2012)

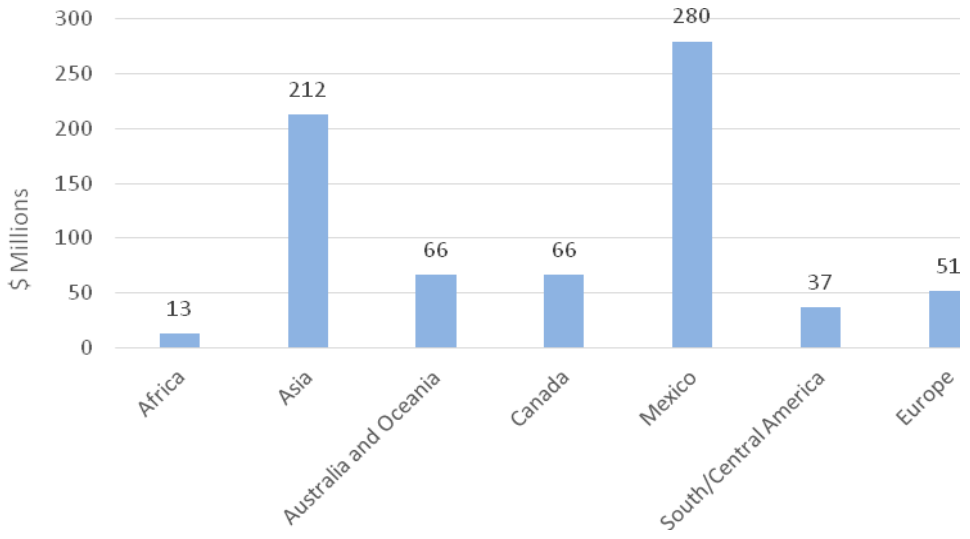


Source: CPCS analysis of Commodity Flow Survey, 2012

2.2.5 International Trade

Exports from Arizona in the food and beverage sector totalled $726 million in 2014 while the state imported $415 million of goods from the same sector. The most important destinations for exports of goods from the food and beverage sector were Mexico followed by Asia.

Figure 2-4: Destinations of Arizonan Food and Beverage Exports in 2014 ($ billions)



Source: CPCS analysis of United States Census Bureau Electronic Export Information. Accessed April 2015.

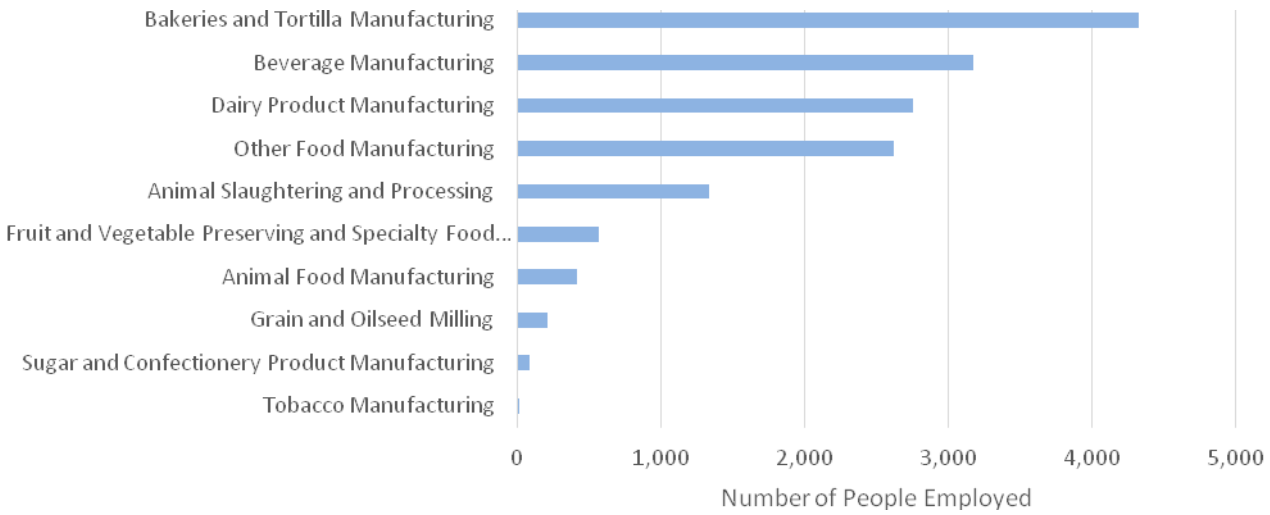
2.2.6 Employment and Wages

In 2013 the food and beverage manufacturing sector employed 212,004 people in Arizona, representing 8.1 percent of total employment in the State (excluding self-employment).[5] The total wages and salaries paid to employees in 2013 was $4.9 billion dollars[6], making the average annual earnings per employee in 2013 approximately $23,100 for the sector. Within the food and beverage sector, annual earnings per employee were higher in the food manufacturing beverage and tobacco product manufacturing industries at approximately $51,000 per year, and lower in the food services and drinking places industry, at $23,100 per year.

The largest industry generating employment in the food and beverage manufacturing subsector is bakery and tortilla manufacturing followed by beverage manufacturing and dairy product manufacturing (Figure 2-5).

[5] Bureau of Economic Analysis Regional Economic Accounts, Personal Income and Employment by State, Wages and Salaries by NAICS Industry.
[6] Bureau of Economic Analysis Regional Economic Accounts, Personal Income and Employment by State, Wages and Salaries by NAICS Industry.

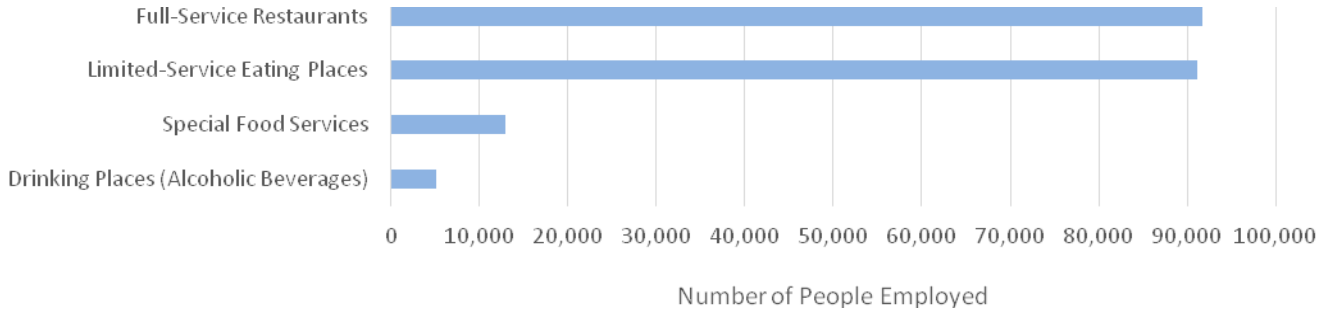
Figure 2-5: Breakdown of Employment in the Food and Beverage Manufacturing Sector in Arizona (2013)



Source: CPCS analysis of Quarterly Workforce Indicators dataset, United States Census Bureau

In the food services and drinking places subsector, full-service restaurants (i.e. sit down restaurants where patrons are served) employ over 90,000 people followed very closely behind by limited-service eating places (i.e. "fast food" restaurants) also employing slightly over 90,000 people in Arizona.

Figure 2-6: Breakdown of Employment in the Food Services and Beverage Serving Sector in Arizona (2013)



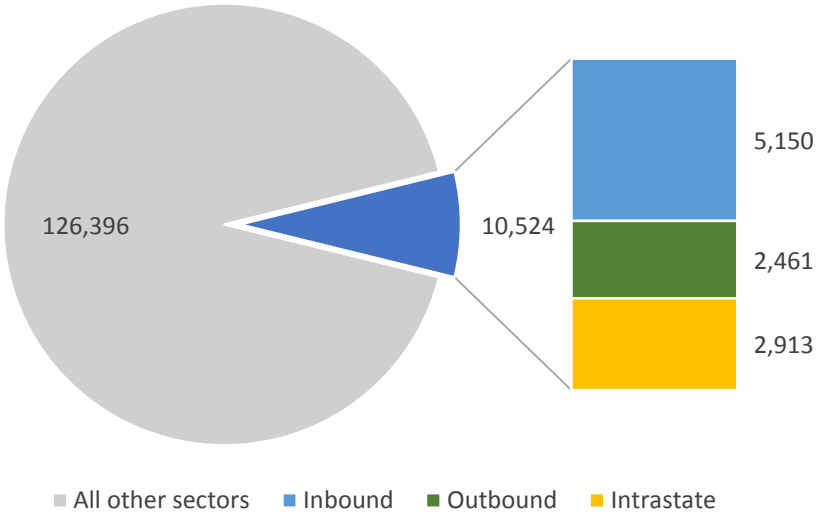
Source: CPCS analysis of Quarterly Workforce Indicators dataset, United States Census Bureau

2.3 Locations and Traffic Profile

The food and beverage sector in Arizona generated 10.5 Mt of freight in 2012, comprising about eight percent of all freight tonnage in the State (Figure 2-7). Around half (5 Mt) was imported from other states some of which was likely originating from overseas markets; 23 percent was exported to other states, some of which was likely destined to overseas markets, and the rest, 27 percent, represents intrastate movements.

The numbers presented here are obtained from Commodity Flow Survey (CFS), 2012. CFS only accounts for domestic movements. These include domestic shipments as well as the domestic components of international supply chains.[7] The volumes presented below illustrate food and beverage sector domestic flows (inbound, outbound, intrastate), in comparison to flows from all other sectors of the economy. The food and beverage sector flows exclude wholesale and retail shipments, which are part of a separate working paper on the wholesale and retail sector.

Figure 2-7: Arizona Food and Beverage Sector Flows Relative to Other Sectors ('000 Tons)



Source: CPCS analysis of Commodity Flow Survey, 2012.

[7] In CFS, the sum of individual state volumes is slightly lower than the national volume which is due to data suppression and rounding in individual state-to-state movements. For consistency across all the graphics (maps and charts), this paper presents the total of state level volumes.

2.3.1 Activity Clusters

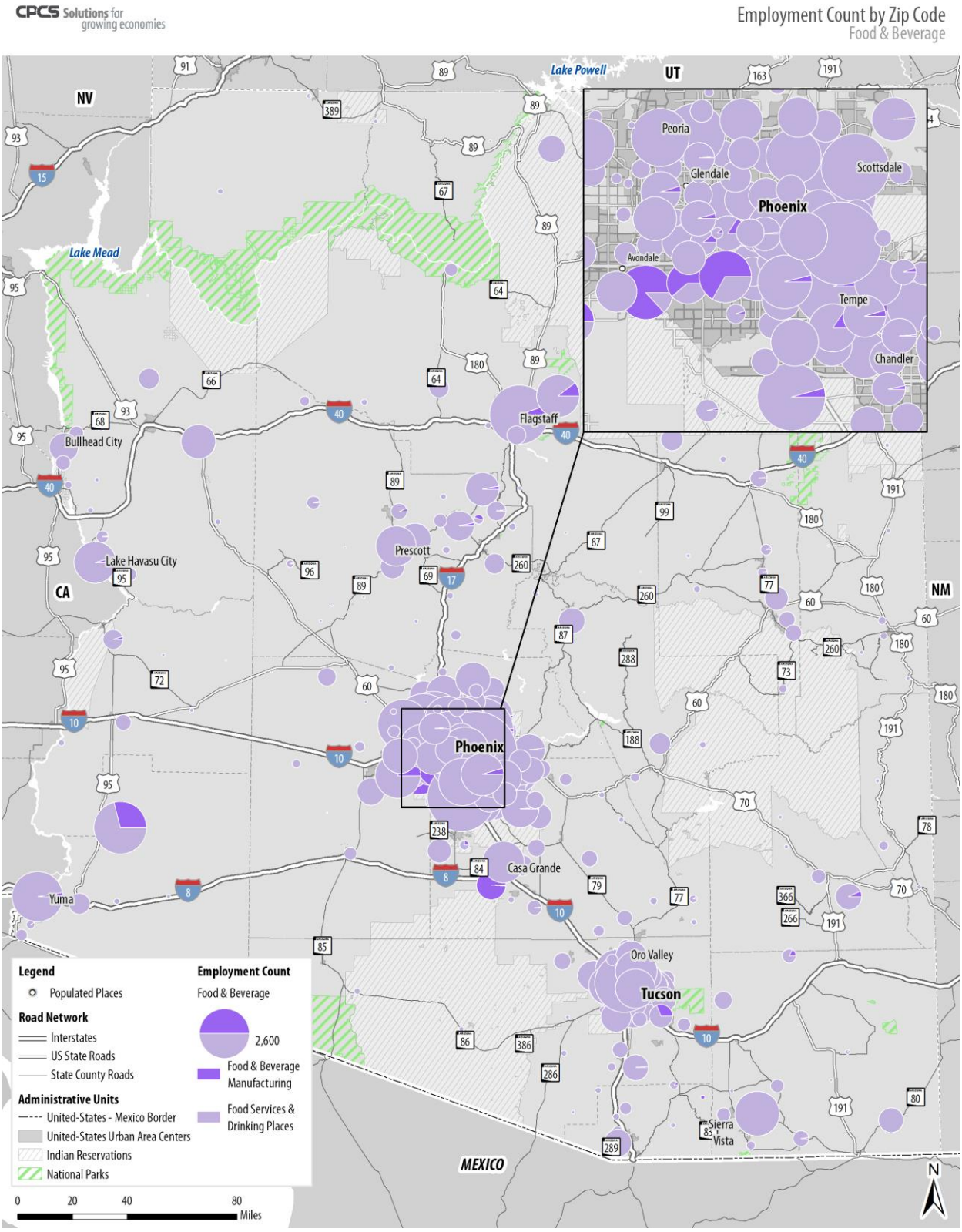
The activity clusters of food and beverage industry are shown by the geographic distribution employment in the sector (Figure 2-9).[8] Food and beverage manufacturing are notably concentrated around the I-10 corridor in Phoenix. Restaurants and bars are clustered around urban areas with high populations, as expected.

Figure 2-8: Example Phoenix Food Distribution Center (Tolleson)

Source: CPCS

[8] Sector-specific employment was estimated at the zip-code level from County Business Pattern Data, 2013 by US Census Bureau, by multiplying the mid-point of employment range and the number of establishments.

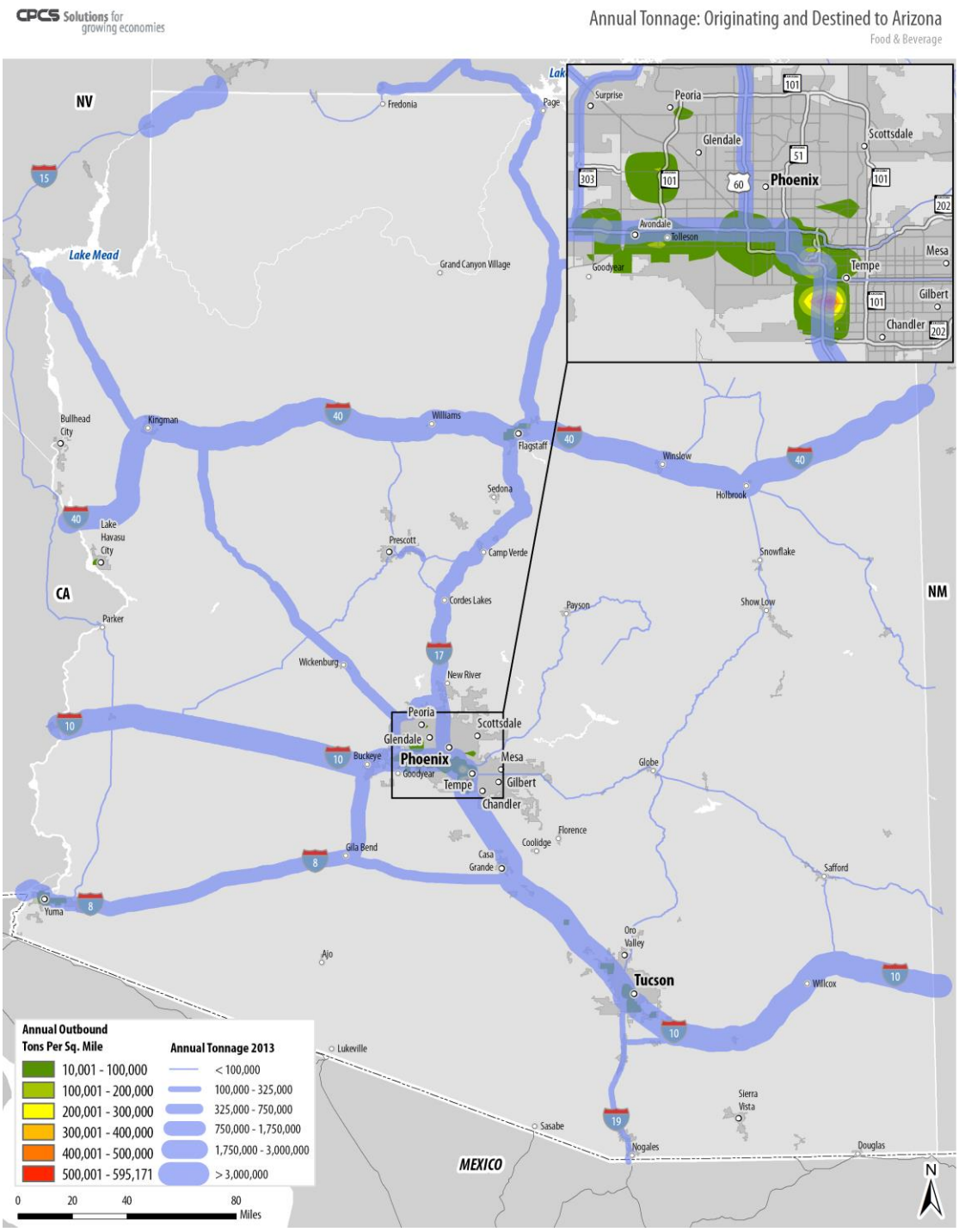
Figure 2-9: Arizona Food and Beverage Sector Employment Clusters



Source: CPCS analysis of County Business Pattern Data, 2013 by US Census Bureau.

Figure 2-10 below combines food and beverage sector commodity flows on highways with their area of production. The clusters were identified from kernel density estimation in ArcGIS using Global Insight's Freight Finder 2013 dataset. The estimated outbound volumes produced by this sector are clustered in the southern parts of Phoenix, and in Tucson, Yuma and Flagstaff. In Phoenix, the major concentration is near Tempe. Only Arizona-generated (originated or destined) flows are shown in the map (not through traffic). The major corridors used by this sector are I-10 and I-17 leading to I-40 eastward. Unsurprisingly, I-10 towards California is the most used highway since California is the biggest domestic trading partner of food and beverage commodities.

Figure 2-10: Arizona Food and Beverage Sector Freight Cluster and Commodity Flow



Source: CPCS analysis of Freight Finder and Transearch 2013

2.3.2 Major Origins and Destinations

Approximately half of the food and beverage sector volumes in Arizona are inbound freight (5 Mt) of which roughly half (2.4 Mt) come from California. Also, nearly half of the total outbound freight (1.1 Mt of 2.4 Mt) goes to California. One stakeholder in the food

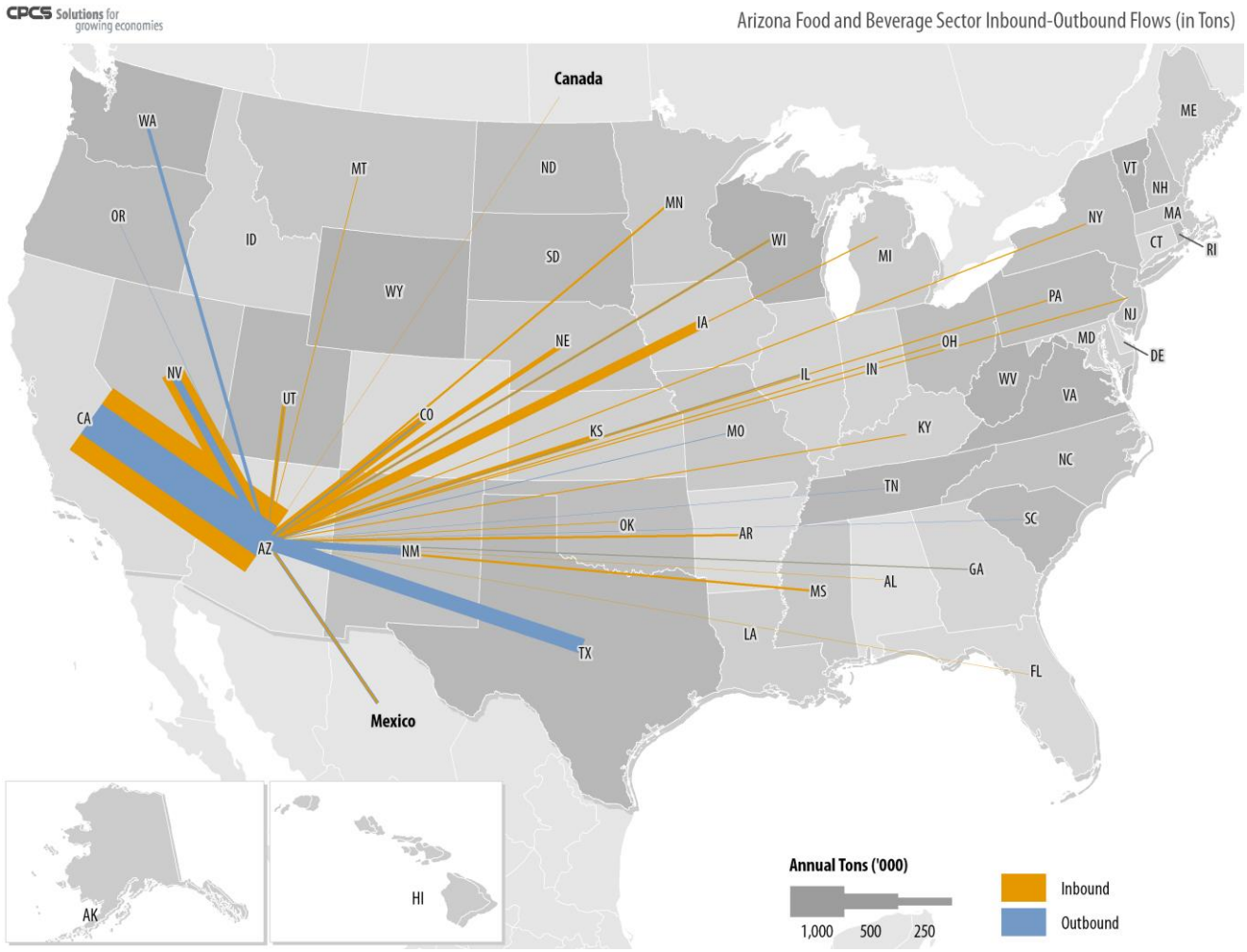
distribution industry indicated that it sources most of its products from western states, which is in line with the data shown in this map.

California is the largest exporter of food in the U.S., for several possible reasons[9] One report indicates that California's large agricultural base and proximity to export infrastructure (ports, airports and highways) contribute to its lead in food production exports.[10] Other studies have also indicated that there are economies of scale in some certain sectors of food production[11] and some studies have noted synergies with respect to firm size.[12] (For example, one study notes that, "commodity processing is being consolidated into more central and automated plants, resulting in closure of many smaller and older plants."[13]) These factors would contribute to California's outsized role in food production.

However, some of the freight flows from and to California can be explained by international imports and exports that are handled first in California, which cannot be separated in the available data from flows originating from or with their ultimate destination in California.

[9] Ceritos College. 2010. Food Manufacturing in California.
[10] Ibid.
[11] Connor, J.M. and Wills, R.L. 1988. Marketing and Market Structure of the U.S. Food Processing Industries. In *Economics of Food Processing in the United States*, eds. McCorkler, C.O., Jr. p. 133.
Gervais, J.-P., et al. 2006. Economies of Scale in the Canadian Food Processing Industry.
[12] The Mclean Group. 2010. California Food Processing: A Powerhouse of Value.
[13] Food Industry Advisory Committee and the California Institute of Food and Agricultural Research University of California, Davis. 2004. California Food Processing Industry Technology Roadmap.

Figure 2-11: Arizona Food and Beverage Sector Inbound-Outbound Tonnages



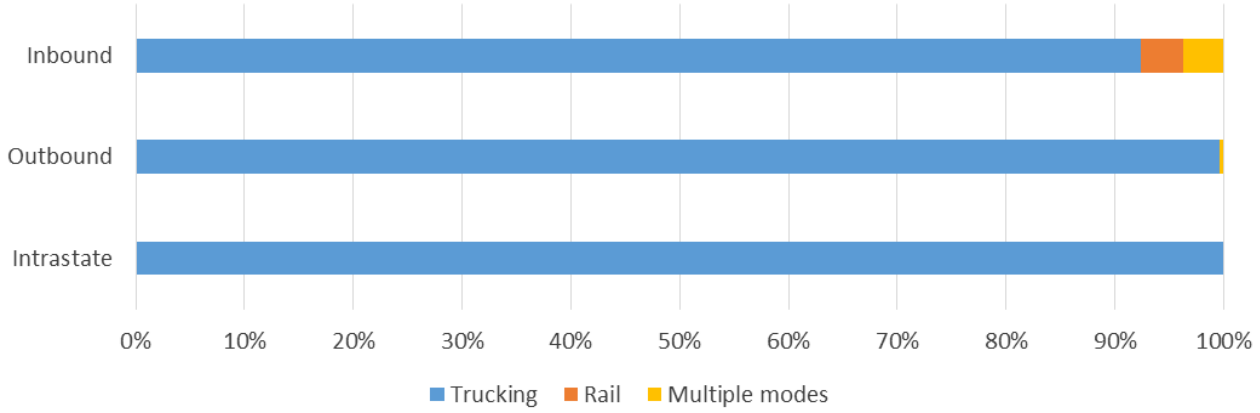
Source: CPCS analysis of Commodity Flow Survey, 2012. The import/export figures were obtained from Freight Analysis Framework 3 estimates for 2012.

2.3.3 Modal Breakdown

Most inbound and outbound food and beverage products are transported by truck, with the exception of some limited inbound products which are transported by rail.[14] The breakdown in this figure is in line with expectations that, with the exception of less-perishable products, most products must be delivered by trucks as the products are (1) perishable (i.e. time-sensitive to some degree), (2) being transported a relatively short distance (e.g. to or from California, or intrastate), and/or (3) being transported to a non-rail served customer base (e.g. restaurants).

[14] In the CFS dataset, the individual mode volumes do not add up to the aggregate "All Mode" which is due to the data suppression and rounding at detailed mode level.

Figure 2-12: Arizona Food and Beverage Sector Volume (Tons) by Mode



Source: CPCS analysis of Commodity Flow Survey, 2012.

3 Supply Chain Structure and Transportation Performance Parameters

Key Messages

Food and beverage sector shippers are concerned about transportation costs, but, given that perishability is a concern for many products, travel time is of greater concern. Reliability is also a concern, though the needs of each subsector, each business, and each product can vary significantly.

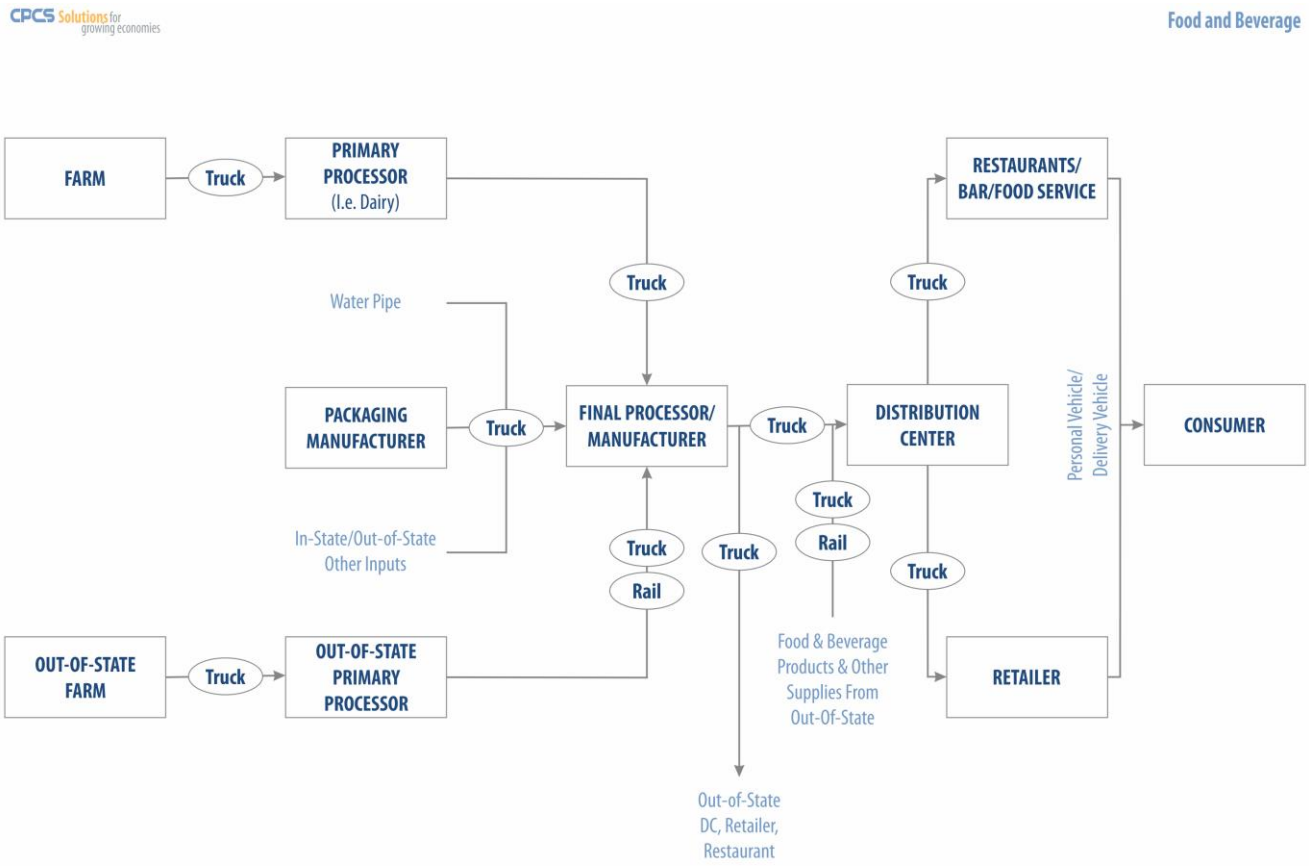
On the manufacturing side, generally speaking, more reliability is required for more perishable products, as they cannot be stockpiled, and vice-versa.

Ensuring adequate (refrigerated) trucking capacity throughout the entire year is a noted concern. There is a high demand for outbound refrigerated trucking capacity in the winter and spring as a result of the Arizona produce harvest, and as a result, there tends to be a shortage of trucks during the produce harvest season. The stakeholder noted that his company often selects trucking companies based on the assurance that they will transport products throughout the year.

3.1 Supply Chain Structure

Figure 3-1 shows a typical food supply chain from farm through to consumers. Agricultural inputs for food manufacturing will often first go through a primary processing plant. For example, corn is processed into corn meal for tortilla and chip making, canola and other oil seeds are processed into oil for frying, and livestock is slaughtered and butchered for use in other products (such as hot dogs, sausage, burgers, etc.). These agricultural inputs, along with other inputs (notably packaging), are then transported to final manufacturing plants mainly by truck, sometimes by rail, and occasionally pipeline.[15]

Figure 3-1: Typical Food and Beverage Sector Supply Chain



Source: CPCS, adapted initially from: Matopoulos, A., et al. "A conceptual framework for supply chain collaboration: empirical evidence from the agri-food industry." *Supply Chain Management: an international journal* 12.3 (2007): 177-186. The figure was further developed based on the results from stakeholder consultations, the data presented in Chapter 2, and information from other sources, such as NCFRP Report 14: "Guidebook for Understanding Urban Goods Movement."

[15] E.g. water from the municipal system for beverage production.

Food and Beverage Distribution at the Port of Tucson

The Port of Tucson is a notable beer and sugar distribution hub in the Southwestern U.S. and an example of the use of rail to import beverage food products. Boxcars of beer and sugar arrive by rail from Mexico, are cross-docked, trans-loaded, and then distributed by truck to customers in Arizona and surrounding states. The Port of Tucson also stores frozen food products, from turkeys to pecans and pistachios, which arrive by truck from a variety of local and regional farms and then are distributed around Arizona, and surrounding states to destination overseas, such as China and Japan, by ocean freight in sea containers via rail through the ports of Los Angeles and Long Beach

Source: Consultations with the Port of Tucson

At the manufacturing plant, inputs are processed into various products. In the case of Arizona, key finished products include packaged beef, dairy products (e.g. cheese and yogurts), tortillas, and other bakery products, among others. These products are then transported to wholesalers, food distributors, restaurants, bars, and other locations serving food. Typically, consumers drive themselves to these establishments, but food can also be delivered.

Beverage production is conceptually similar to food production (see box below) though alcohol products typically come from out of state. With the exception of microbreweries in the state, which are allowed to distribute their own products, most beer and wine products are delivered from out of state suppliers to in state wholesalers. After coming to rest in a wholesale facility, alcohol products are loaded onto trucks, about half of which are destined for restaurants, and the other half to retailers.

Though there are some exceptions, most products are transported by truck between locations in the supply chain. As noted in Chapter 2, most food and beverage product flows are either intrastate, or to or from California, and the most important international destination of food and beverage exports is Mexico. As such, the length of haul for most food and beverage sector shipments is relatively short and, in particular, below the distance at which rail shipments would be cost effective. Additionally, for food and beverage product flows destined to retail or food service locations in urban centers, truck shipments are the only feasible option.

Beverage Manufacturing Supply Chain

. . .Production facilities receive raw materials for beverages and packaging entirely from domestic sources, including concentrate, sweetener, water and gasses, and empty bottles and cans. Water is city water piped in locally; some chemicals and liquid sweetener may arrive by rail; everything else arrives by truck, mostly in full loads. There are full distribution functions at all production facilities, and there is an additional set of dedicated distribution centers (DCs) that exclusively perform warehousing and delivery… Customer deliveries then originate either from a production facility or a dedicated DC... Different truck vehicle types are employed for different delivery sizes and functions, broken broadly into bulk (high-volume stores), side loader (convenience store and restaurant), and fill service (vending machine) retail channels. . . .

Text Source: Rhodes et al. 2012. NCFRP Report 14: "Guidebook for Understanding Urban Goods Movement"

Shipments between manufacturing facilities and distribution centers typically move in full truckload shipments. Food distributors will receive products from multiple suppliers in truckload and less-than-truck load quantities. Some distributors will blend products,[16] others will simply repackage products from multiple sources. Deliveries to urban areas will typically use smaller trucks or vans. One bottling company notes that it also exports finished products by air and ocean freight.[17]

Figure 3-2: Refrigerated Trailer

Source: United Trailer Leasing

Many food and beverage products – notably meat and dairy products, as well as other agricultural products such as fresh produce – need to remain chilled when shipped to maintain product quality and "[maximize] shelf life and . . . commercial potential."[18] For example, beef should be transported between 32°F to 34°F. Mechanical refrigeration is the most commonly-used approach in the United States. The mechanical refrigeration unit is typically mounted on the front of vans (for local movements) and trailers (for longer-haul movements) (Figure 3-2: Refrigerated Trailer); it can also be installed on containers or rail cars. These units, which have diesel engines, have to comply with applicable air emissions regulations, such as those by CARB (California Air Resources Board).

3.2 Transportation Performance Parameters

Food and beverage sector shippers are concerned about transportation costs, but are relatively more concerned about travel time and reliability (particularly compared to other sectors[19]), given the sensitive handling and temperature requirements of many products. As one report into the regional food transportation supply chain notes:

> *Distance-to-market gives local product an advantage in terms of product quality, as long as the cold chain is protected. As the time en route to market increases, product freshness*

[16] E.g. Denmark Foods, an Arizona-based meat processor, custom blends products, as noted on its website.
[17] E.g. Arizona Production and Distribution, as noted on its website.
[18] Rodrigue, J.-P. 2014. Reefers in North American Cold Chain Logistics: Evidence from Western Canadian Supply Chains.
[19] According to the 2013 Commodity Flow Survey, commodity flows for the food and beverage sector represent approximately 7.7% of shipments by weight and 6.9% of shipments by value, indicating the average value-to-weight ratio is $0.9 per ton. In comparison, at the low end of the value-to-weight-ratio spectrum of the 10 sectors studied, the mining sector has an average value-to-weight ratio of $0.082 per ton, and at the high end, the high-tech manufacturing sector has an average value-to-weight ratio of $160 per ton.

decreases, and more shrinkage occurs – a concern especially with refrigerated fresh fruits and vegetables.[20]

As a result, travel time and cost are both considered in long-term strategic decision making regarding plant and distribution center locations. One stakeholder in the food and beverage distribution industry noted that they will locate distribution centres close to major population centres, and most of their trucks are not equipped for long-haul movements (less than 350 miles) as they only have a day cab. As such, any distribution operations must be made within a day (as defined by hours of service regulations.) Similarly, locations of some food and beverage manufacturing plants are driven by the availability of inputs. For example, meat plants must be located in close proximity to livestock producers, as it is easier to transport finished meat products longer distances than livestock; the latter must be done very carefully to ensure the humane treatment of animals. However, once a strategic decision has been made to locate a plant, there is less flexibility to alter transportation decisions based on travel time.

All food and beverage subsectors demand some reliability, though the needs of each subsector, each business, and even each product can vary significantly. For example, one food service industry source notes: "what may fit for a casual dining concept—which has room for more inventory and fewer weekly deliveries—won't fit at a quick-serve restaurant that drives volume and has less cooler and freezer space."[21] This comment was echoed in consultations, which noted that some high volume restaurants are quite sensitive to reliable transportation – they will require an early morning delivery of certain products to allow time for unpacking and preparation before the lunchtime rush. Smaller "mom-and-pop" restaurants may have more flexibility in terms of their delivery time, as they have more storage space or drive less volume.

Frito-Lay's Casa Grande chip plant provides an example of the variation in reliability needs in one location. As described in the text box below, some of the plant's inputs arrive by rail and are stored on site (e.g. corn). Because of the availability of storage and the less-perishable nature of these inputs, the deliveries do not need to be as reliable. However, stakeholders noted that if a rail shipment is significantly delayed, it can disrupt production over a longer period due to the larger volumes involved in a rail shipment. By contrast, the plant receives 10 semi-trailer loads per day of potatoes. Because of the high-volumes required and the higher-perishability of potatoes, nearly just-in-time reliability is required. However, stakeholders noted that if one potato shipment were delayed, the production disruption would be shorter. Ultimately, the higher the value and/or perishability of the product in manufacturing, the more likely that reliability will be a concern.

[20] Center for Integrated Agricultural Systems. 2014. Networking Across the Supply Chain: Transportation Innovations in Local and Regional Food Systems.
[21] Todd Bernitt, general manager for C.H. Robinson, a logistics provider, in O'Reilly, J. 2012. Restaurant Logistics: Serving up the Perfect Meal. *Inbound Logistics.*

Frito-Lay Casa Grande Chip Plant

With a rail spur leading directly to the facility, materials arrive by train or by Frito-Lay's massive semitrailer fleet. . . Frito-Lay has one of the largest private semitrailer fleets in the U.S. . . . Semitrailers of potatoes arrive at the plant daily. Potatoes used in Frito-Lay products are grown by farmers throughout North America. The company's agronomy group in Rhinelander, Wis., develops the chipping potatoes and contracts with growers. . . . Oil arrives at the plant via 10 rail cars a month. The Casa Grande facility uses sunflower, corn and canola oil. . . . Frito-Lay operates two corn facilities, one in Sidney, Ill., and the other in Gothenburg, Neb. Employees at those facilities procure all the corn used in Frito-Lay products. Corn arrives in Casa Grande by rail car and is stored in silos on site. . . The Casa Grande site was chosen by Frito-Lay because of the proximity to Interstates 8 and 10, which means "[Frito-Lay] can get to a lot of markets quickly". . .
Chips made in Casa Grande are delivered in seven states — Arizona, Nevada, Utah, New Mexico, Colorado, Texas and California. . .

Text Source: Comments made in: Ridenour, S. 2013. Frito-Lay plant in Casa Grande to mark 30th anniversary. *Casa Grande Dispatch*.
Photo Source: Frito-Lay Website.

One other factor that was raised, which could broadly fall under the "risk" or "cost" category, is ensuring adequate trucking capacity throughout the entire year. One stakeholder indicated that there is a high demand for outbound refrigerated trucking capacity in the winter and spring as a result of the Arizona produce harvest season and accordingly, there tends to be a shortage of trucks during the season. The individual noted that the company he works for selects trucking companies based on the assurance that they will transport products throughout the year.

3.3 Barriers to Transportation Performance

Most stakeholders were concerned about regulatory issues affecting the performance and cost of truck transportation, rather than with infrastructure per se. Most stakeholders did not raise significant concerns with the transportation system itself, though specific concerns were noted.

Congestion

Congestion and ensuring the state-of-good-repair were the two main infrastructure concerns highlighted. One stakeholder noted that there is a lot of congestion on the I-10, and drivers will often re-route onto the I-15 or I-40 if they do not absolutely need to use the I-10. While not attempting to discount the need to maintain a state of good repair, one stakeholder perceived that there is frequently congestion on the I-10 created by ongoing system preservation work and suggested that a longer-term strategy for capacity expansion should be considered. For example, instead of undertaking a one-lane-at-a-time expansion, the stakeholder suggested considering a larger expansion to minimize congestion caused by

ongoing maintenance (by providing some additional capacity) and by new construction (by reducing the number of times new construction is required).

Related to this issue, another stakeholder was concerned with the possibility that there is not now, nor will there be in the future, adequate transportation funding to ensure the system is maintained in a state-of-good repair, such that safety issues are created for drivers, particularly in rural areas.

Finally, though it was not raised specifically in the context of Arizona, given that most food and beverage products are ultimately destined to urban areas, urban design standards and regulations can at times represent a barrier.[22]

Alternative Fuel Infrastructure

One stakeholder noted that some distributors are using alternative fuel vehicles in the state (e.g. CNG [compressed natural gas]), but there are not enough CNG fueling stations. There has been some federal support, but some companies have had to set up their own infrastructure.[23] This stakeholder indicated that there can be several advantages of alternative fuels, including cleaner burning engines that get better mileage. However, additional fuelling infrastructure would need to be provided to further these efforts.

Regulatory Issues

The key issues raised by stakeholders related to availability of truck transportation services and the cost implications of a lack of availability. Notably, shippers and carriers expressed concern regarding:

- a shortage of drivers, and how increasingly stringent regulatory requirements (e.g. hours of service) exacerbate the shortage; and
- truck engine emissions regulations, particularly in California;

Informants were concerned that more stringent truck driver hours-of-service regulations effectively lowers the supply of available truck drivers. In 2011, the Federal Motor Carrier Safety Administrated published new hours of service rules, effective in 2013. In them was an additional requirement that drivers "may not drive after 60/70 hours on duty in 7/8 consecutive days" without a 34 hour "restart" between periods.[24] Effective December 2014, this requirement has been suspended by Congress.

[22] See e.g. Chapter five (Regulations Impacting Urban Goods Movement) NCFRP Report 14: Guidebook for Understanding Urban Goods Movement.
[23] Data from the United States Department of Energy, Alternative Fuels Data Center, indicates that there are 36 CNG fueling stations in Arizona, of which 12 are public and 24 are private. Most are clustered around Phoenix and Tucson.
[24] FMCSA. 2014. Summary of Hours of Service Regulations.

Hours of service regulations may be particularly onerous for the food service sector, where drivers are required to make frequent stops on their delivery routes. One recent finding from a conference on regional food supply chains was that:

> *Under current regulations, delays at loading docks count as hours of service. Consequently, delays in the first and last miles reduce actual hauling time and negatively impact profit margins by necessitating that haulers and distributors run more trucks.* [25]

Managing this issue requires a great deal of coordination between the transportation carrier and the shipper, which was identified as an issue in the same conference:

> *Transportation challenges identified at the conference include lack of coordination between the transportation providers and the very small and very large facilities that supply and receive local food. Small-scale suppliers require numerous pick-ups and sometimes have inadequate physical infrastructure, labor flexibility and/or limited knowledge of the time sensitivity associated with hours of service regulations and the cost of delays. As a result, drivers will sometimes arrive for a pick-up at a smaller supplier only to discover that product is not yet packed or palletized or that there is no one there to load the truck. Large-scale suppliers, on the other hand, face delays as a result of traffic congestion caused by numerous distributors arriving at the same time.* [26]

In other words, the delivery profile in the food service sector, combined with stricter hours of service regulations, could increase the likelihood that that food distributors need to add additional drivers to meet deliveries. Carriers and their drivers, who often perform similar routes, do try to coordinate with receivers to avoid or manage delays, but it is not always possible prior to every delivery.

One stakeholder was concerned about the need for and challenges associated with receiving a Commercial Driver License (CDL). He indicated that CDL licensing requirements may be overly onerous, particularly in the food service subsector in which many of the deliveries to food service are short-haul and with smaller trucks. CDLs, which are issued by the state, but based on federal requirements, are required to operate any vehicle with a Gross Vehicle Weight Rating of 26,001 pounds or more as well as some other commercial vehicles.[27] To some extent, Arizona addresses this concern by allowing drivers as young as 18 to receive an intrastate CDL.[28] The stakeholder was concerned that the unavailability of testing centers for CDLs may contribute to discouraging new entrants to the industry, particularly in rural areas. Another stakeholder noted that not only is driving not perceived as a good or lucrative job,

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[25] Center for Integrated Agricultural Systems. 2014. Networking Across the Supply Chain: Transportation Innovations in Local and Regional Food Systems.

[26] Ibid.

[27] CDLs originated from the requirements of the federal Commercial Motor Vehicle Act of 1986.
ADOT. Commercial Driver License.
FMCSA. 2014. Commercial Driver's License Program.

[28] One must be 21 years old to receive an interstate CDL.
ADOT. Commercial Driver License, License Information, CDL Instruction Permit.

but the mining and heavy construction industry may be attracting the target population. However, this concern was not universal – some stakeholders noted that recruiting drivers in Arizona has not been overly onerous.

Some stakeholders indicated that they found it particularly challenging to recruit not only drivers in Arizona, but also logistics managers as well. One stakeholder speculated that the perception that Arizona is a state for retirees might contribute to this challenge; that is, that Arizona is not considered a desirable place for young people to move to.

The other issue expressed by carriers and shippers was the cost implications of CARB (California Air Resource Board) truck emissions regulations. These requirements particularly affect the food and beverage sector as there are requirements that apply not only to the truck engines themselves, but also the engine that generates power for refrigerated vehicles and trailers.[29] As shown in Figure 2-11, a significant volume of food and beverage products are transported to or from California, making any trucks and refrigerated units operating on these lanes subject to these regulations. The cost of required updates for the trucks themselves can be on the order of $15,000 for older trucks.[30]

3.4 Trends and Implications

There are several trends in the food supply chain that may have implications on the transportation system.

Sustainable Food and Food Traceability

There is a growing emphasis on the consumption of locally produced food and beverages to enhance (1) the traceability of food in the supply chain (i.e. the ability to know where a product comes from) and (2) the consumer perception that the product is sustainably grown. For example, Chipotle Mexican Grill:

> *. . . plans to source more than 10 million pounds of locally grown produce—including bell peppers, red onions, jalapenos, oregano, and romaine lettuce—up from five million pounds two years ago. The program procures food from farms within 350 miles of restaurants where it will be served. . . . Chipotle is also receiving fresher product and reducing transportation costs—even if it sacrifices economies of scale.* [31]

As the last sentence notes, the growing push for locally sourced products could result in shorter hauls, but diminished economies of scale, as it may be more difficult to consolidate shipments within a smaller area. As such, this trend could lead to additional, smaller freight vehicles.

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[29] The CARB requirements are described in more detail on their website.
CARB. 2015. Transport Refrigeration Unit (TRU or Reefer) ATCM.

[30] Bowman, R. 2013. California Truckers Say They're Choking on State's Emission Rules. *Forbes.*

[31] O'Reilly, J. 2012. Restaurant Logistics: Serving up the Perfect Meal. *Inbound Logistics.*

On Demand Food Delivery

Several companies are expanding the use of on-demand food delivery, through mobile applications (apps). An article notes that several fast food retailers have announced plans to expand food delivery.[32] Uber is also offering an on-demand food delivery service, UberEATS, in select markets. These services pick up meals from existing restaurants and deliver them to consumers. At the food retail end of the supply chain, there is a similar trend towards grocery delivery, though there are two models: delivery from existing stores and delivery from existing warehouses.[33]

There are several possible implications of these findings. Notably, shippers and carriers providing delivery services will be increasingly concerned about travel time and travel time reliability in urban areas. As a recent article on the trend points out, "[it] is reasonable to expect that shoppers' expectations for speed of delivery will keep increasing (one to two-hour delivery windows will likely be the norm)."[34,35] As such, if congestion were to increase, carriers would need to add additional vehicles and drivers to meet delivery windows, increasing transportation costs. Ultimately though, as this trend is still developing, it is difficult to assess its full implications. Further, other technological trends, such as the development of autonomous vehicles and delivery drones, which could facilitate the on-demand food delivery, would have broader implications on the transportation system.

[32] Gillies, T. 2015. We've Made the Donuts. Now it's Time to Deliver Them: Dunkin. *CNBC.*
[33] Oliver, D. 2015. The future of grocery delivery: What manufacturers and retailers should anticipate. *Food Drive.*
[34] Ibid.
[35] At the extreme, Amazon has recently launched one-hour delivery in London in the United Kingdom. Collins, K. 2015. Amazon Prime Now Launches One-Hour Delivery in London. *Wired.co.uk.*

4 Sector Priorities for Transportation System Performance Improvement

Key Messages

The sector priorities for transportation system performance improvement include:

- Minimize congestion on the I-10 and routes around Phoenix
- Permit longer and heavier vehicles on key routes
- Provide funding for and/or coordinate the development alternative fuel infrastructure
- Increase the availability of logistics training, and CDL training and testing centers

4.1 Priority Improvements Needs

Generally, most stakeholders were not overly concerned with the transportation system in Arizona. Most stakeholders were concerned with attracting sufficient qualified personnel to drive (and manage) in the trucking industry. Related to this issue, they were also interested in increasing the truck weight or length limit, which would allow them to ship more product with fewer trucks.

Minimize congestion on the I-10 and routes around Phoenix

Though stakeholders were generally satisfied with the roadway system in Arizona, they did express concerns regarding congestion around Phoenix, and notably on the I-10. Increasing congestion increases travel times and lowers reliability, both of which decrease the productivity of trucks and their drivers (i.e. more trucks and drivers would be required to make the same number of deliveries). As such, minimizing congestion on this corridor for goods movement appears to be the key infrastructure priority for the industry.

One stakeholder commented that perhaps capacity creation and lane additions could take into account long-term growth trajectories in order to minimize the number of disruptive construction periods on select roadways

In terms of minimizing congestion for goods movement, another approach would be to provide truck-only lanes on key routes. As shown in the employment map in Figure 2-9, there is a cluster of food manufacturing industries around Tolleson and Casa Grande in Phoenix; for some manufacturers, a notable fraction of their production would be destined for Phoenix proper, and to a lesser extent to Tucson. To this end, providing a truck-only lane into Phoenix (and potentially to Tucson) would facilitate the distribution of food and beverage products.

For example, stakeholders at Frito-Lay indicated that many of the distribution centers they serve are adjacent to the I-10 in Phoenix; as such, a truck-only lane from Casa Grande to Phoenix could minimize the impact of congestion on their shipments.

Permit longer and heavier vehicles on key routes

Several of the stakeholders noted that allowing heavier or longer vehicles would permit them to ship more of their products with fewer trucks and drivers, alleviating some of the concern with regard to the driver shortage. Again, because many of the food and beverage manufacturers are located on the outskirts of Phoenix, stakeholders noted that permitting these heavier and longer operations on key routes around Phoenix (and between Phoenix and Tucson), including appropriate access, would be most beneficial.

Allowing heavier loads beyond the 80,000 lbs vehicle weight limit set by the U.S. Department of Transportation would help food manufacturers that load at the weight limit to reduce the number of trucks required. Products such as boxed meats and beverages would likely load at

the weight limit. Allowing trucks to go from holding 44,000 lbs to 54,000 lbs of cargo could reduce the number of trucks on the order of 20 percent, for example.

Other stakeholders, particularly those that typically load at the volume limit of the vehicle, indicated that permitting longer trailers and/or long combination vehicles could also reduce the number required, also alleviating concerns regarding a shortage of drivers. Two specific examples were cited:

- Allow 59 foot trailers, which are allowed in Texas,[36] as opposed to the 57 foot – six inch trailers which are allowed in Arizona. This change would increase the volume shipped per truck, both intrastate and to Texas, which is the second most important domestic destination of food and beverage products after California, as shown in Figure 2-11.

- Allow long combination vehicles, such as those allowed in Alberta, Canada on select routes (e.g. the Turnpike double with two 53 foot trailers back-to-back). These vehicles can have gross vehicle weights of up to 139,700 lbs and increase the volume of product that can be hauled with one truck.[37]

Provide funding for and/or coordinate the development alternative fuel infrastructure

One of the stakeholders noted that some companies that distribute in urban areas have converted their trucks to alternative fuels, such as CNG. However, he indicated that the lack of fuelling infrastructure represents a barrier to further use of such technology. The Alternative Fuels Data Center notes that there are several potential public and private benefits to the use of natural gas, including increased energy security, improved vehicle performance, and lower level of some emissions.[38] As such, Arizona could facilitate the adoption of this technology by providing funding and assisting in coordinating development.

Increase the availability of logistics training, and CDL training and testing centers

Though the concern was not universal, some stakeholders expressed concern about a shortage of drivers in the industry, and the difficulty in recruiting drivers and qualified logistics managers in Arizona. One suggestion offered was to ensure the adequacy of CDL licensing centers, which was noted as a potential barrier to attracting drivers in rural areas, as well as to make CDL requirements less onerous for shorter-haul drivers. In terms of attracting managers to the industry, strategies should be considered to ensure that Arizona is an attractive place for young, educated people to relocate, and not only perceived as a destination for retirees or snowbirds from Canada and the Midwestern U.S.

[36] FHWA. 2004. Federal Size Regulations for Commercial Motor Vehicles.
[37] Montufar & Associates and EBA Engineering Consultants Ltd. 2007. Long Combination Vehicle (LCV) Safety Performance in Alberta: 1999–2005: Final Report.
[38] U.S. Department of Energy. Natural Gas Benefits and Considerations.

Increase the Availability of Truck Stops

One of the stakeholders noted that the new driver hours-of-service regulations would require an increase in the number of truck stops where drivers can safely pull over and stop. To this end, ADOT has conducted a statewide inventory of truck parking facilities to assess the supply of safe parking spaces versus growing demand.

Appendix A: Stakeholders Consulted

All stakeholders consulted requested anonymity as part of the consultation process.