Our Freight Mobility

REGIONAL FREIGHT PLAN

Pima Association of Governments

FINAL - MARCH 22, 2018

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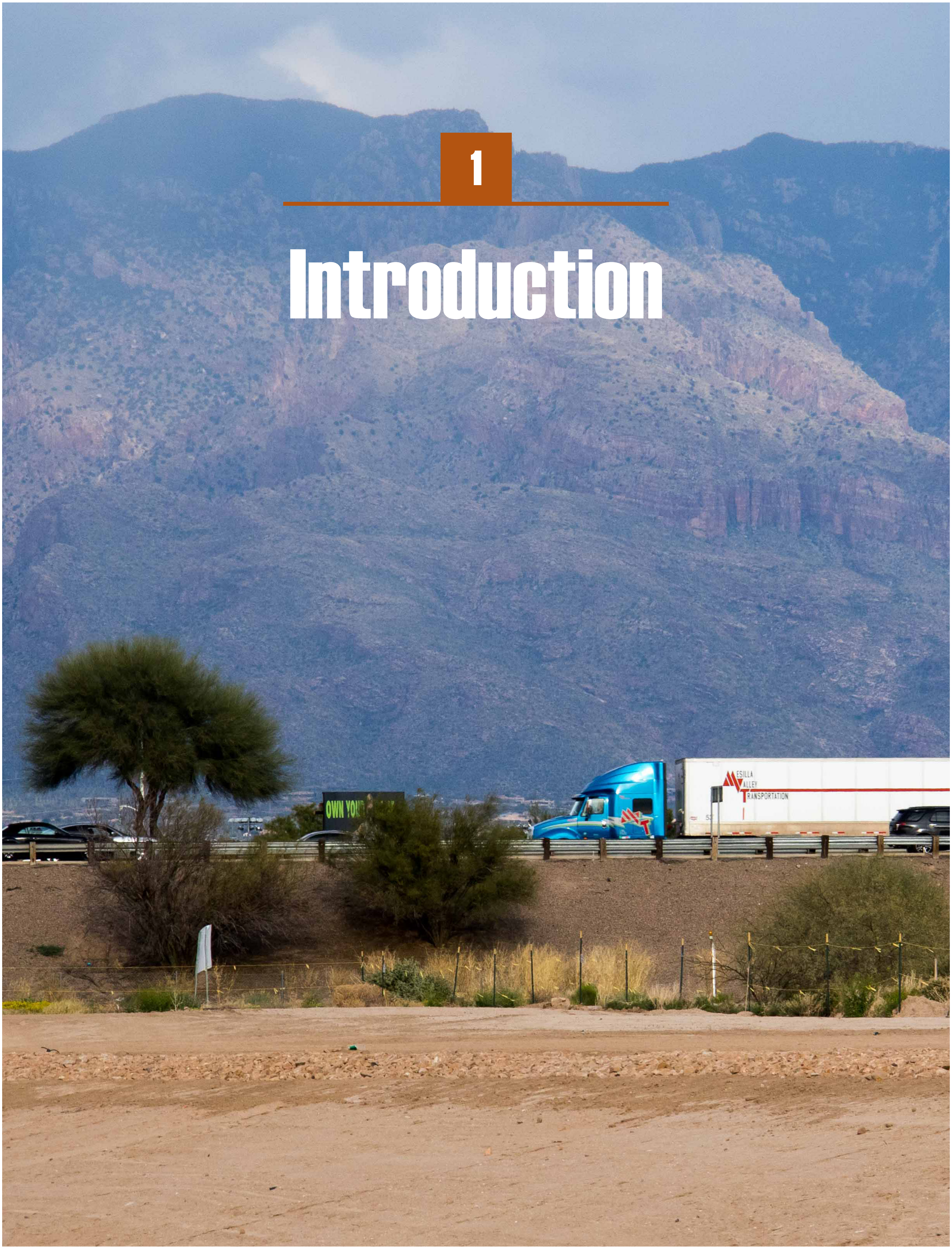
1

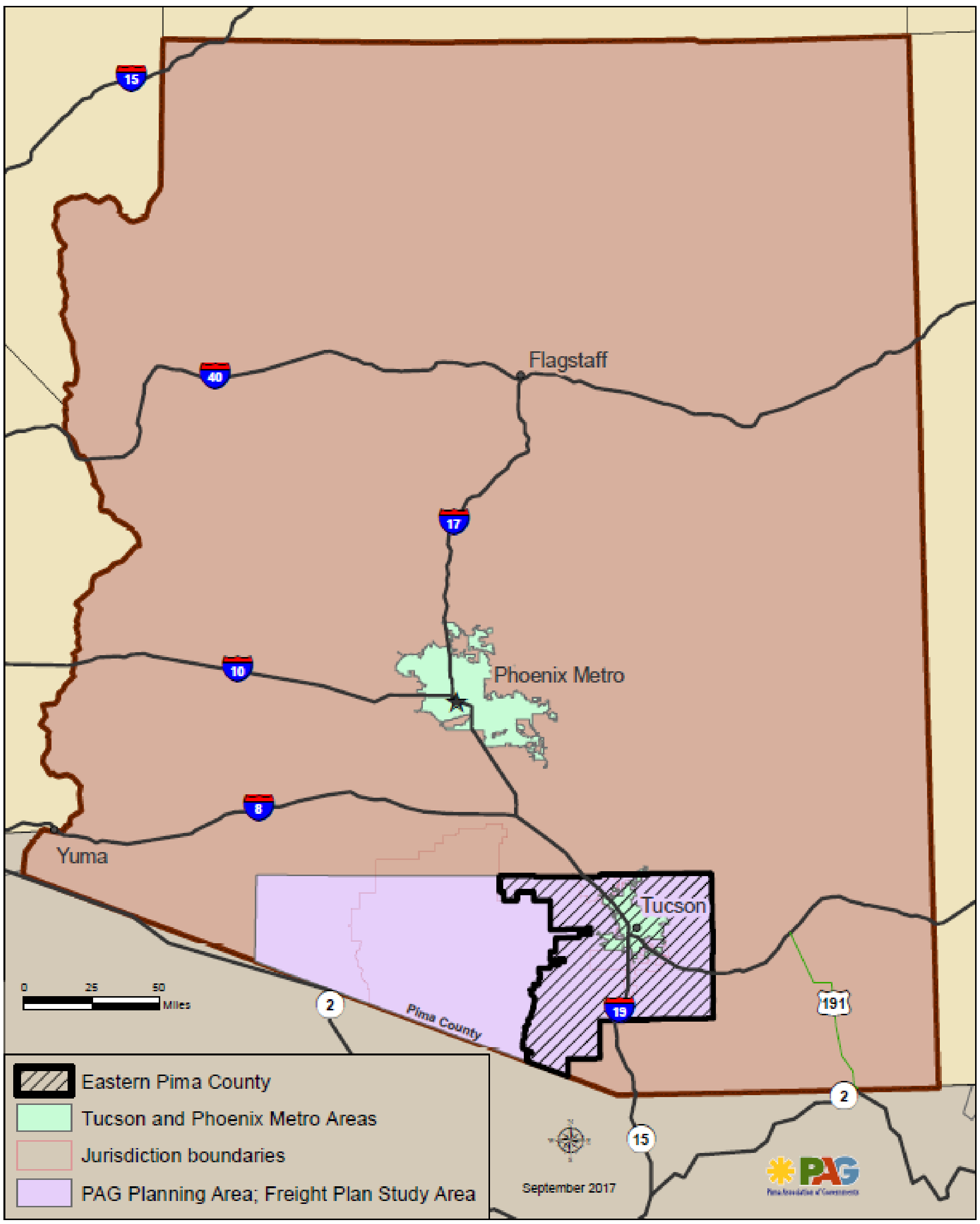
Introduction



1. Introduction

Pima Association of Governments' (PAG) Regional Freight Plan (Freight Plan) captures current levels of freight activity in the PAG planning area (the PAG region) and identifies freight transportation planning goals and strategies that will support efforts to strengthen the region's economic vitality. The PAG region is shown in **Figure 1.1.** Note that the vast majority of the county's population and transportation activity is concentrated in eastern Pima County.

Figure 1.1 Regional Freight Plan study area



Purpose of the PAG Regional Freight Plan

The Freight Plan, the first for the PAG region, was developed to 1) provide a better understanding of the performance of the region's freight transportation system and 2) identify transportation investments that support a goods-based economy and enhance the quality of life in the region. PAG interviewed members of the freight industry, including transportation service providers, and community stakeholders to capture their respective needs, issues and constraints.

The Freight Plan complements the federally required Arizona State Freight Plan. The State Freight Plan, which was developed by the Arizona Department of Transportation (ADOT), identifies issues with the state-owned-and-operated freight system and recommends improvements. This plan, however, focuses largely on operational, regulatory and infrastructure needs on the regional freight transportation system within Pima County. To advance regional transportation planning efforts, the Freight Plan identifies goals and strategies that will improve connections to interstates and intermodal facilities and, ultimately, to domestic and global markets beyond.

The Freight Plan considers existing economic development initiatives and underlying economic conditions, such as workforce training and development, development incentives and regulatory climate, to inform strategy development in long-term transportation planning and identify future investment needs.

REGIONAL TRANSPORTATION VISION

A state-of-the-art, reliable, multimodal and environmentally responsible regional transportation system that is continuously maintained, interconnected and integrated with sustainable land use patterns to support a high quality of life and a healthy, safe and economically vibrant region.

PAG 2045 Regional Mobility and Accessibility Plan (RMAP)

Once identified strategies are implemented, an improved flow of goods should strengthen the competitive position of freight industry employers, retailers and export-oriented businesses and make the region more attractive to companies looking to locate or expand in Pima County.

Overview of Regional Freight Transportation

From fresh produce delivered to the local supermarket to direct delivery of electronics to the home—and local product exported to all corners of the globe—the PAG region's economy depends on the efficient movement of freight. On-time shipping and receiving of goods requires a vast and reliable freight network including, but not limited to, ports, highways, railways, airports, warehouses and distribution centers.

Located within the Arizona Sun Corridor — one of the largest and fastest-growing megaregions in the United States — the PAG region is well positioned for the efficient movement of goods. Situated at the crossroads of Interstate 10, a key east-west national corridor, and Interstate 19, a key north-south corridor, the PAG region can easily access both domestic and international markets. While I-10 connects Tucson to major markets in Texas and California, including the busiest U.S. container ports in Los Angeles and Long Beach, I-19 provides a critical connection with Mexico, the region's top international trading partner. Growth in Mexico's middle class and its manufacturing sector opens up expanded opportunities for new supply-chain connections and commercial development.

The PAG region (**Figure 1.1**) has a unique opportunity to capitalize on its transportation, distribution and logistics assets to support job growth, business attraction, economic diversification and quality of life. Healthy freight activity supports jobs not only in transportation and logistics but also in retail, construction, manufacturing and other sectors.

The region's prosperity, therefore, is linked to ongoing freight transportation strategies that will address system infrastructure and investment needs.

Structure of the Regional Freight Plan

The Freight Plan is organized into six chapters, providing an overview of freight's role in the regional economy, identifying key freight assets and presenting freight needs and recommendations.

Chapter 1. Introduction – This chapter provides the purpose of the Freight Plan and an overview of regional freight transportation.

Chapter 2. The Region's Freight Economy – This chapter provides a general overview of how the freight system fits within the overall economy of the PAG region.

Chapter 3. Freight Infrastructure Profile – This chapter presents an inventory of regional freight assets and gives a description of the system's operating characteristics. It also includes the newly identified Regional Freight Corridor Network.

Chapter 4. Trends, Challenges and Needs – This chapter identifies opportunities and needs within the regional freight transportation system.

Chapter 5. Recommendations – This chapter includes recommended goals, strategies and actions for addressing freight-related opportunities and needs, and recommended projects.

Chapter 6. Conclusion – This chapter provides a summary of the Freight Plan and outlines findings and takeaways and a brief overview of roles associated with next steps by which projects and recommendations can become a reality.

Planning Process for the Regional Freight Plan

The Freight Plan was developed over 18 months, and the planning process was conducted in four phases as shown in **Table 1.1**.

In the first phase, the project team reviewed a number of relevant economic development and comprehensive plans, as well as freight studies, from across the state and region to develop freight-specific goals and strategies. This step ensured that the Freight Plan goals and strategies recommendations were consistent with and supported the PAG region's overall economic development priorities. The second phase consisted of analyzing freight commodity data and conducting interviews with key industry groups. In the third phase, the project team worked with stakeholders to identify freight needs and opportunities. In the fourth phase, the project team worked with the region's jurisdictions to develop a recommended list of actions and projects.

The development of the Freight Plan was guided at every stage by a task force of stakeholders representing PAG member jurisdictions, economic development experts, utility companies, freight carriers and others. The Freight Plan Task Force provided technical expertise about freight movement in the region and key insights about broader regional economic development considerations.

Freight on the move through downtown Tucson

Table 1.1 Planning process for the Regional Freight Plan

Phase	Dates	Tasks
Phase 1 Plan Preparation	February 2016 to June 2016	• Research best practices • Review state and regional plans • Assemble Freight Plan Task Force • Develop Freight Plan goals
Phase 2 Regional Freight Profile	June 2016 to April 2017	• Analyze freight commodity flow data • Inventory freight assets • Interview freight stakeholders • Develop commodity flow and asset inventory reports
Phase 3 Needs and Opportunities Identification	February 2017 to June 2017	• Develop methodology for identifying needs and opportunities • Meet with PAG region jurisdictions • Identify freight needs and opportunities
Phase 4 Project Recommendations	June 2017 to October 2017	• Identify potential projects and recommendations to address needs and opportunities • Work with jurisdictions and stakeholders to refine project and recommendations list

Regional Freight Plan Goals

The Freight Plan advances the vision and freight-specific goals established in the 2045 Regional Mobility and Accessibility Plan (RMAP), PAG's federally mandated long-range transportation plan. The RMAP was adopted in May 2016 by the PAG Regional Council, a nine-member governing body that includes chief elected officials from local, state and tribal governments. The RMAP establishes a vision for a multimodal and intermodal transportation network that efficiently moves people and goods throughout the PAG region.

To achieve that vision, the RMAP proposes specific projects and strategies to serve the needs of the population. The Freight Plan—with its own set of goals and strategies for a specific mode—expands upon that vision.

2045 PAG RMAP Vision The 2045 RMAP envisions a state-of-the-art, reliable, multimodal and environmentally responsible regional transportation system that is continuously maintained, interconnected and integrated with sustainable land use patterns to support a high quality of life and a healthy, safe and economically vibrant region.

2045 PAG RMAP System Goal – **Freight and Economic Growth** Regional freight transportation infrastructure supports global competitiveness, economic activity and job growth by providing for the efficient movement of goods within the PAG region, giving access to national and international markets, and improving intermodal connections.

REGIONAL FREIGHT PLAN GOALS

Three key goals define the structure of the Freight Plan and provide an organizing mechanism for strategies and actions required to further advance regional freight policy. The key goals were developed from a review of relevant national, state and regional guiding policy documents and economic development plans. These objectives serve to complement and support the projects, goals and performance measures set forth in the PAG 2045 RMAP, National Highway Freight Program and Arizona State Freight Plan. The Freight Plan goals are for the region to achieve:

1. A safe and reliable multimodal freight system with the capacity to meet current and future demand.

2. Accessibility and connectivity of freight transport to domestic and international markets.

3. Enhanced partnerships between the public and private sectors to support the movement of goods and increase understanding of the importance of freight to the region's economy.

Federal Freight Considerations

The Freight Plan addresses the increased federal focus on freight transportation planning required under the Fixing America's Surface Transportation Act of 2015 (FAST Act).

Fixing America's Surface Transportation Act

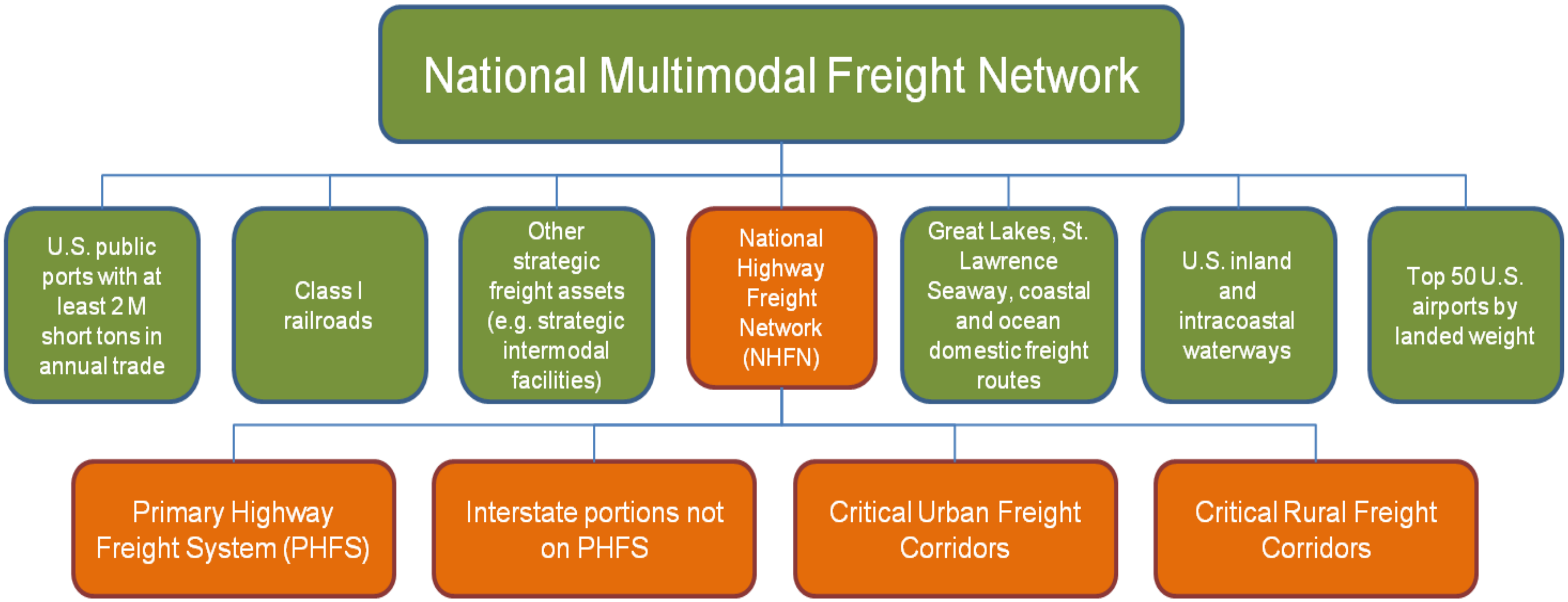
The FAST Act, the current five-year surface transportation bill, outlines more comprehensive provisions for freight than any prior federal transportation bill. It is the first federal transportation bill with dedicated freight funding. The FAST Act created a $4.5 billion competitive grant program for nationally significant freight and highway projects, previously known as FASTLANE and now called the Infrastructure for Rebuilding America (INFRA) Grant Program. The FAST Act also created a $6.3 billion formula funding program to improve the newly designated National Highway Freight Network (NHFN). The State of Arizona already has benefited from the FASTLANE competitive grant program with a $54 million award in 2016 to widen portions of I-10 between Tucson and Phoenix.

In addition to its freight funding programs, the FAST Act also includes several new freight-focused planning requirements. Notably, the U.S. Department of Transportation (USDOT) is required to develop a National Freight Strategic Plan, which assesses the condition and performance of the nation's freight system and provides forecasts and improvement strategies. To guide resources and investment to the most critical pieces of transportation infrastructure for freight, USDOT is identifying a National Multimodal Freight Network (NMFN), which considers multiple strategic national freight assets beyond the NHFN, including key multimodal facilities, such as public ports, waterways and Class I railroads (**Figure 1.2**).

The FAST Act also stipulates that states develop their own state freight plans within two years of the bill's enactment. ADOT completed a freight plan for the State of Arizona in the fall of 2017. The Arizona State Freight Plan looks at critical statewide freight needs and opportunities, focusing primarily on the state-owned roadway system (including interstates and state routes).

The PAG Regional Freight Plan, though not a federal requirement, complements the State Freight Plan by looking in more detail at regional freight system performance and how the regional system ties together with the state transportation system. The Regional Freight Plan strengthens how PAG can address federal transportation planning factors, such as supporting the economic vitality of the PAG region, increasing accessibility and mobility of people and freight, and enhancing the integration and connectivity of the transportation system across and between modes.

Figure 1.2 National Multimodal Freight Network



Freight Plan Implementation

PAG is the federally designated metropolitan planning organization (MPO) for the PAG planning area, with defined responsibilities for planning for the region's transportation improvements and establishing processes by which transportation funding is prioritized. PAG does not own or operate any transportation facilities and does not, therefore, implement transportation projects or many of the other plan recommendations.

How the projects and recommendations identified in the Freight Plan are ultimately implemented depends on project scale. Generally, a larger project will need to be sponsored by one or more of the jurisdictions within Pima County, submitted for consideration in the regional planning process, and evaluated within the context of overall regional priorities and needs. If the project is a regional priority of jurisdictions, stakeholders and the public, it can move into design and construction if and when funds become available. Some smaller projects and non-infrastructure recommendations may be implemented outside of the regional process by the individual jurisdictions.

Inclusion of a project or recommendation in the Freight Plan does not guarantee that the project or recommendation will be implemented. Rather, the plan brings attention to specific freight-related needs and opportunities and why it's important to consider freight transportation during future planning efforts.

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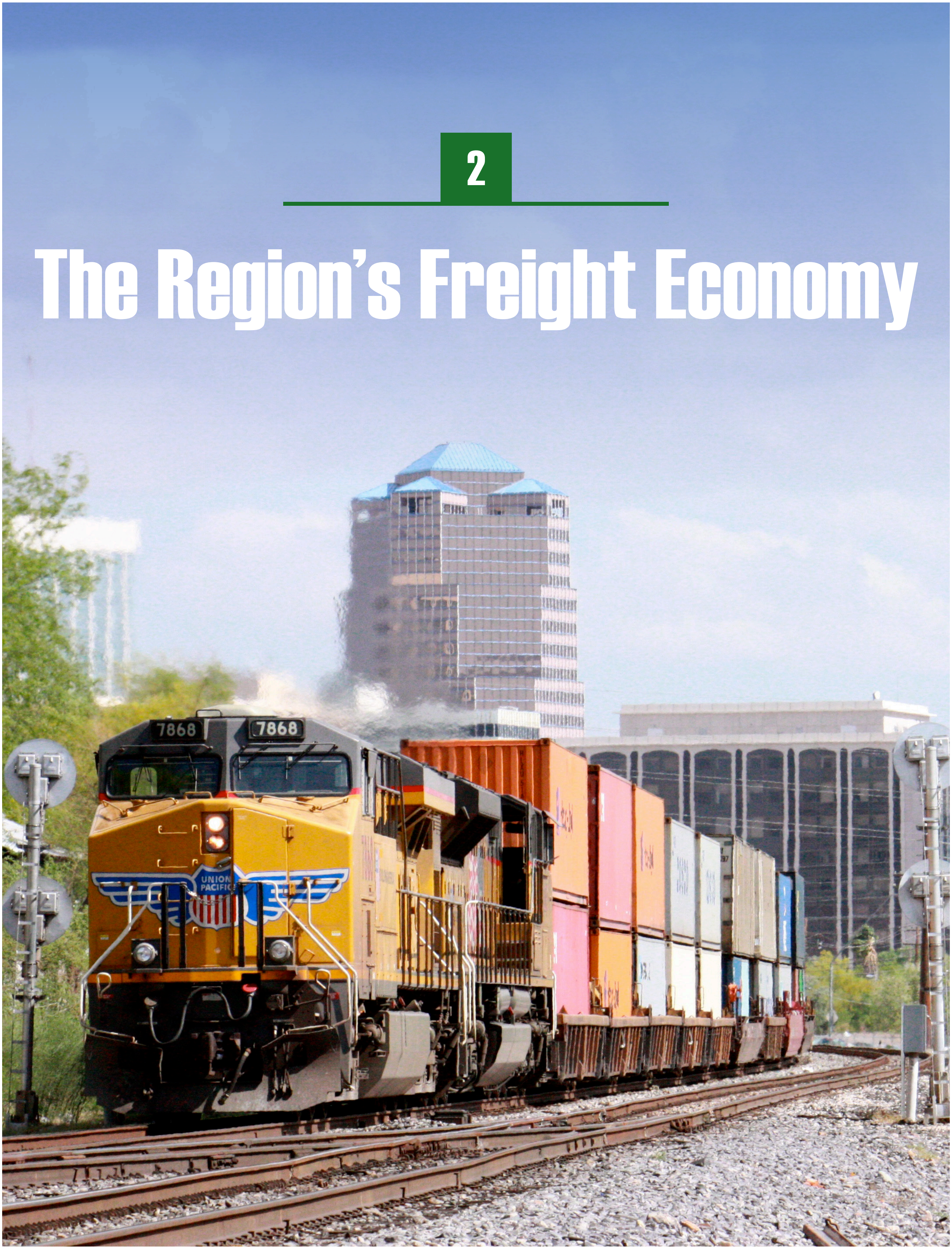
The Region's Freight Economy



2. The Region's Freight Economy

Freight movement in the PAG region is shaped by a variety of factors, including population and economic trends. This chapter provides a general overview of the region's population and economy, focusing on business sectors and industries that rely most heavily on the efficient movement of goods.

Overview

During the second half of the 20th century and into the first years of the 21st century, the PAG region experienced economic and population growth rates that outpaced the nation. The region's weather, unique desert environment, natural resources and affordability have made it a major destination for tourists, retirees, and those seeking economic opportunity or a change of scenery. These patterns of in-migration have historically supported growth in residential construction, health care, hospitality and retail. The presence of the University of Arizona and Davis-Monthan Air Force Base has made government a major sector in the local economy, and a cluster of aerospace and defense firms — in particular, Raytheon Missile Systems — has bolstered advanced manufacturing.

Although the region has a strong aerospace and defense cluster, among other clusters, the bulk of the job growth occurs in lower-wage employment sectors or jobs that are more susceptible to economic downturns, most recently evidenced by the lingering impact of the Great Recession, from 2008-2010. In particular, service, construction and public sectors are still struggling to recover jobs based on a combination of stagnant population growth, reduced government spending and low consumer spending.

Given the region's heavy reliance on service and government jobs, the freight industry and stakeholders recognize the importance of diversifying the economy by attracting higher-wage, primary employers and strengthening the tradable goods, and transportation and logistics sectors. These economic goals are expressed in Sun Corridor Inc.'s *Economic Blueprint,*[1] Pima County's *Economic Development Plan*, the Joint Planning and Advisory Council's (JPAC) *Freight Transportation Framework Study,*[2] and elsewhere.[3]

Tradable goods are items or services that are produced locally and exported for consumption outside of the PAG region and, in turn, bring new money into the region. The tradable goods sector also has a strong job-multiplier effect. One study found that

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[1] Sun Corridor Inc. is a non-profit economic agency for southern Arizona with a primary goal of facilitating primary (non-retail) job and investment growth in the region.

[2] JPAC is a joint initiative of the MPOs and COGs in the Sun Corridor Megaregion (Maricopa Association of Governments (MAG), PAG, Central Arizona Association of Governments (CAG), and the Sun Corridor Metropolitan Planning Organization (SCMPO)) to coordinate planning activities to build a strong and successful Sun Corridor.

[3] For a complete list of documents and plans reviewed in the development of the Freight Plan, see Appendix 3.

for each job created in a tradable goods-producing business, a region can expect to see an additional 1.6 jobs added in non-tradable sectors. The multiplier factor is stronger for skilled jobs with an additional 2.5[4] jobs created. Expanding the tradable goods sector then can be expected to increase household incomes, create complementary local jobs and make the region's economy more resilient against cyclical economic disruptions.

Since the tradable goods sector in the Tucson metropolitan region is weak compared with similarly sized metropolitan regions, taking steps to establish a high-performing freight network with modern and efficient infrastructure is critical to improving this sector, which can lead to far-reaching economic benefits.

Population

Population is an important driver of freight demand in a region, since an increase or decline in the population growth rate impacts the local demand for consumer goods.

Between 1970 and the mid-1990s, as the population of the United States migrated away from the Northeast and the Upper Midwest to the South and Southwest, the PAG region regularly grew at rates between 2 percent and 4 percent.[5] During those decades, the region grew 3.5 times faster than the overall United States,[6] attracting new residents from across the country and abroad. The region's fast rate of growth drove high demand for new housing, which sustained strong residential construction and retail sectors.

However, in the late 1990s, the rate of regional population growth began to slow, falling to historically low rates in the years following the global housing crisis and subsequent economic recession in 2008 (**Figure 2.1**). Since 2010, population growth has hovered between 0.5 percent and 1 percent annually, not yet returning to pre-recession rates. Pima County currently has over 1 million residents.

In general, the PAG region lags the Phoenix metropolitan region and the state in terms of population growth (**Figure 2.2**). Since 2000, Maricopa County and the State of Arizona have experienced growth rates that have been, on average, 50 percent to 60 percent higher than Pima County, even though overall growth patterns have largely been consistent among the three geographies.[7] Seventy-five percent of Arizona's total population resides in either Maricopa County or Pima County.[8]

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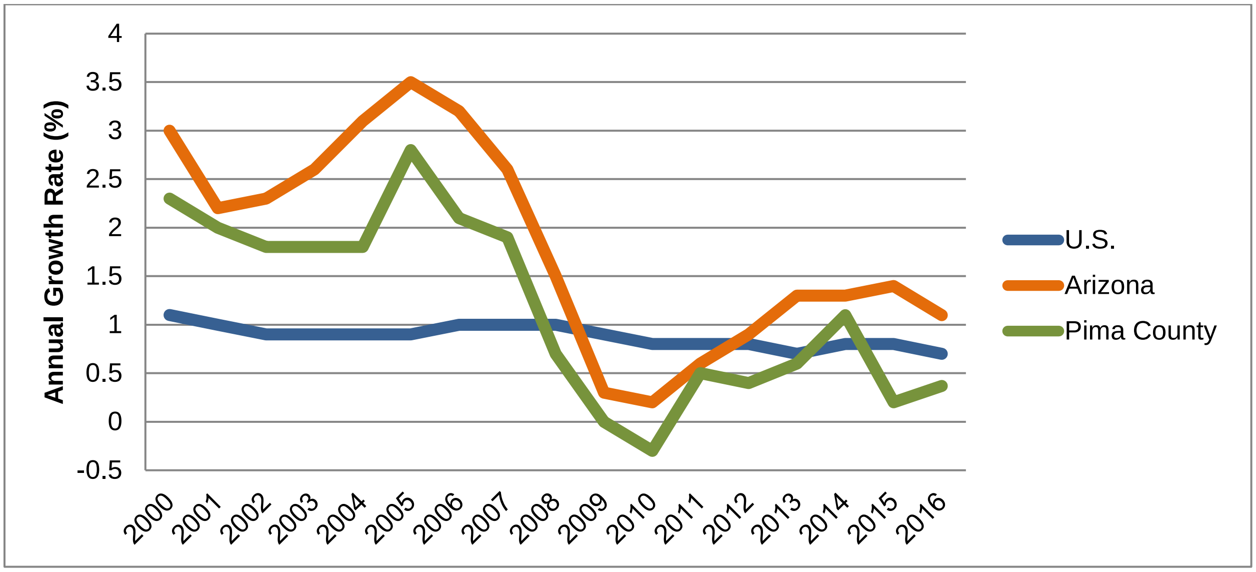
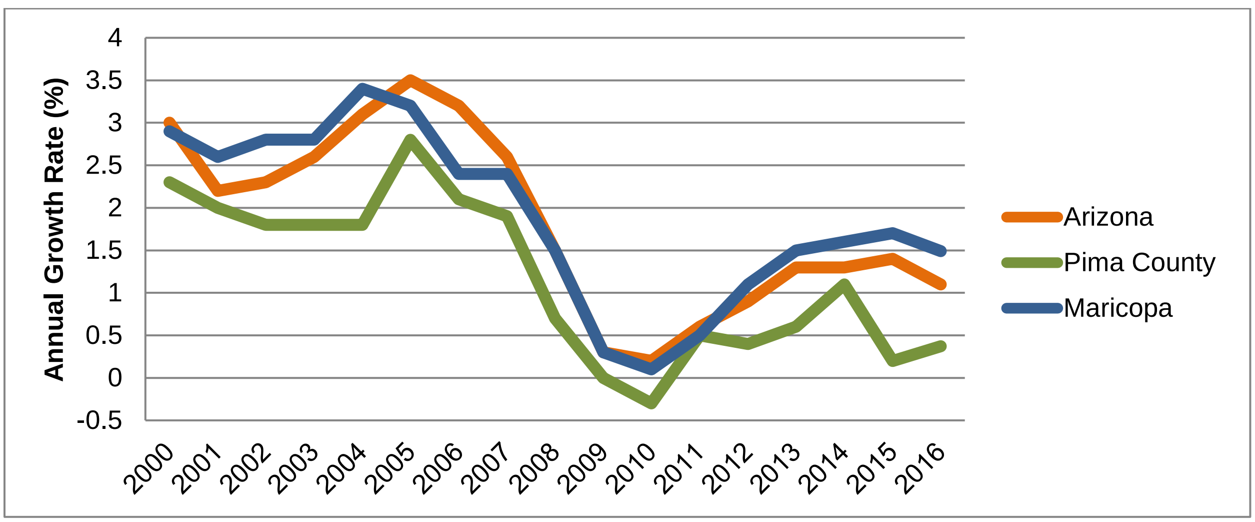
[4] Moretti, Enrico. 2010. "Local Multipliers." American Economic Review, 100(2):373-77.
[5] Arizona Indicators. http://arizonaindicators.org/demographics/population.
[6] Ibid.
[7] Note: Pima and Maricopa counties are treated as equivalent with the Tucson and Phoenix metropolitan regions for the purposes of this document.
[8] Arizona Department of Administration, Office of Economic Opportunity, July 1, 2016, Population Estimates.

Figure 2.1 Population growth rates, 2000–2016



Source: https://mapazdashboard.arizona.edu

Figure 2.2 Population growth rates, 2000–2016



Source: https://mapazdashboard.arizona.edu

Current population projections for the region assume that future growth will be slower than the historic growth rate. The Arizona Office of Employment and Population Statistics projects that Pima County's population will grow at an annual rate of 1 percent or less in the coming years.[9] However, even at this lower growth rate, the region is still projected to add more than 350,000 residents by 2045. The Freight Plan uses a

[9] Arizona Department of Administration, Office of Employment and Population Statistics, 2015-2050 State and County Population Projections, Medium Series.

planning horizon of 2045 in order to be consistent with PAG's adopted long-range plan, the 2045 RMAP. Growth along the broader Sun Corridor is expected to remain strong, with projections assuming 56 percent growth among core counties (**Table 2.1**).[10]

Anticipated future growth in the Sun Corridor will increase demand for more regionally produced goods and, in turn, increase demand for the necessary labor force to fill related jobs.

Population is an important driver of freight demand, but perhaps more significant forces determine the volume of freight movement in the region. Among these is the demand for regional products, such as copper and aerospace equipment, from customers outside southern Arizona; consumption characteristics within the region, and the PAG region's location relative to global supply chains.

Table 2.1 Population growth projections of core Sun Corridor counties

	Pima	Maricopa	Pinal	Santa Cruz	Total
2015	1,009,400	4,076,400	406,500	50,300	**5,542,600**
2020	1,064,400	4,480,900	463,500	53,900	**6,062,700**
2025	1,121,900	4,886,000	527,900	57,400	**6,593,200**
2030	1,176,400	5,280,100	604,800	60,700	**7,122,000**
2035	1,228,200	5,665,900	696,700	63,600	**7,654,400**
2040	1,276,700	6,031,000	800,700	66,200	**8,174,600**
2045	1,323,200	6,371,600	913,300	68,300	**8,676,400**

Source: Arizona Department of Administration, Office of Employment Statistics, 2015-2050 State and County Population Projections, Medium Series

Regional Economic Characteristics

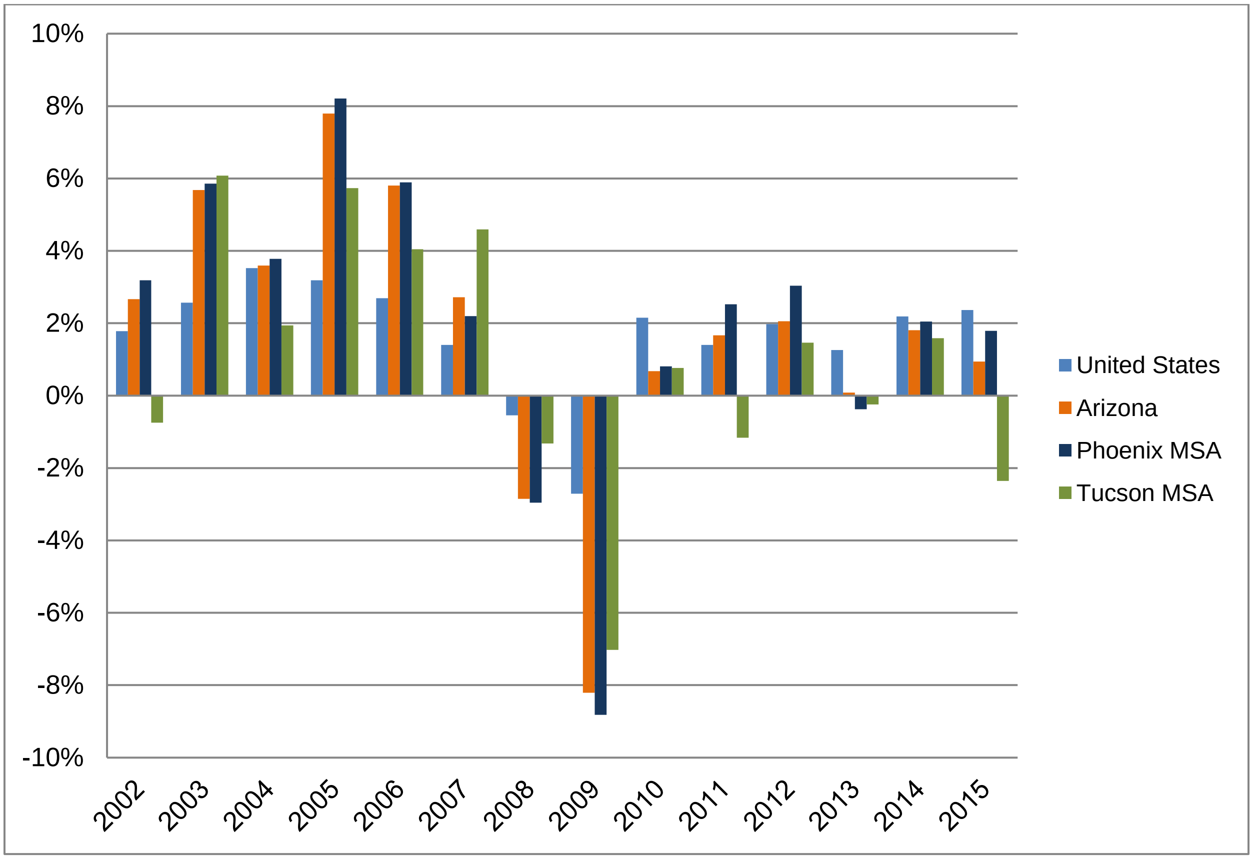
In 2015, the gross domestic product (GDP) of the PAG region was $36 billion in current dollars.[11] GDP measures economic activity in a geographic area at a given time and considers an area's spending, investment and production. Regional GDP provides useful information about the strength of the local economy and, when adjusted for inflation, reveals how a region's economy changes over time.

[10] Ibid.

[11] Bureau of Economic Analysis, Gross domestic product (GDP) by metropolitan area (millions of current dollars).

From 2001 to 2007, the PAG region's real, or inflation-adjusted, GDP grew 3.6 percent annually, which was higher than the rate of population growth.[12] However, the region's GDP was hit extremely hard by the Great Recession, shrinking by 8.3 percent between 2007 and 2009.[13] For comparison, during the same period, inflation-adjusted GDP of the United States decreased by 3.2 percent, while the State of Arizona's GDP went down by 11.6 percent, an indication of just how pronounced the effects of the recession were in this region and state (**Figure 2.3**).

Figure 2.3 Annual growth of real GDP[14]

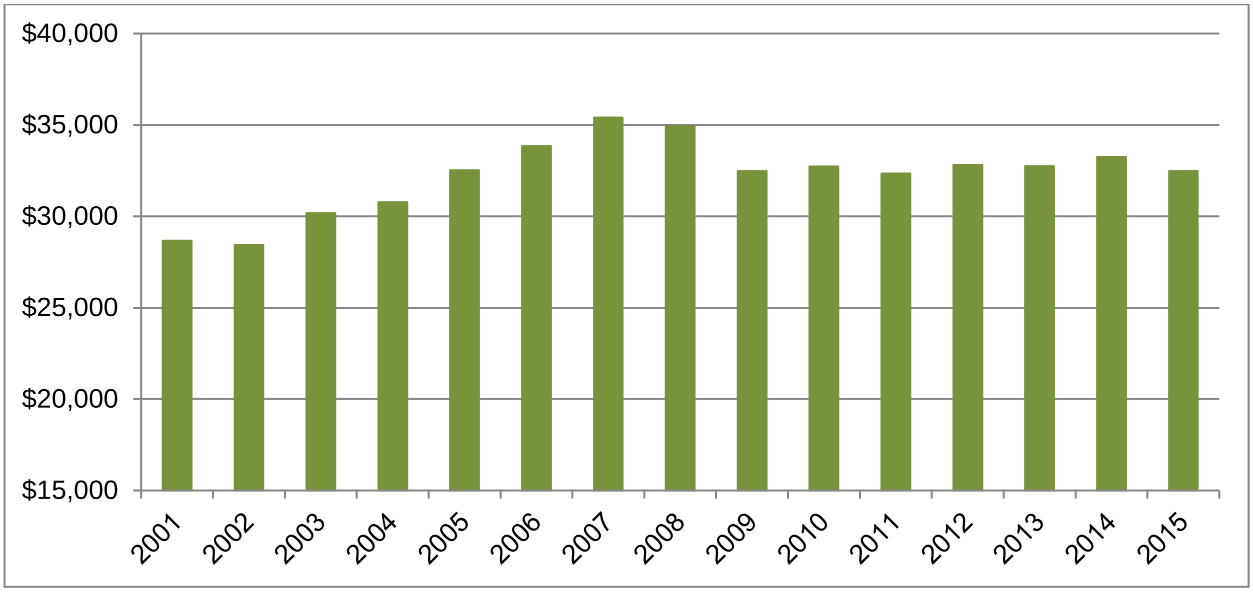


Source: Bureau of Economic Analysis, Real GDP by state and metropolitan area, 2009 chained dollars

[12] Bureau of Economic Analysis, Real GDP by metropolitan area (millions of chained 2009 dollars).
[13] Ibid.
[14] Note: MSA refers to metropolitan statistical area.

As of 2015, the PAG region's economy had not yet fully recovered from the recession, with the inflation-adjusted GDP still lower than its 2007 high (**Figure 2.4**).[15]

Figure 2.4 PAG region real GDP, 2001-2015



Source: Bureau of Economic Analysis, Real GDP by metropolitan area, 2009 chained dollars

Per capita GDP enables comparison of relative economic performance between regions. Arizona — and the PAG region, in particular — have relatively low real GDP per capita when compared with the nation and other Western metropolitan areas. In 2015, for example, the PAG region's inflation-adjusted per capita GDP was around $32,000, which was $17,000 below the national average. The Phoenix metro's per capita GDP was just over $43,000 (**Table 2.2**).[16]

Another way of assessing regional economic health is looking at wages and employment in Pima County. This approach not only is more tangible in terms of how the economy is performing for the region's residents but also gives an indication of the region's potential consumption of goods.

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[15] Bureau of Economic Analysis, Real GDP by metropolitan area (millions of chained 2009 dollars).

[16] Note: Per capita GDP is an average measure and does not account for differences in cost of living between regions or the level of regional inequality.

Table 2.2 GDP per capita 2010-2015, selected geographies

Area[17]	2010	2011	2012	2013	2014	2015
United States	**47,287**	**47,586**	**48,156**	**48,396**	**49,091**	**49,844**
Arizona	38,170	38,442	38,732	38,303	38,438	38,244
Phoenix, AZ	43,006	43,627	44,155	43,260	43,311	43,264
Tucson, AZ	**33,325**	**32,731**	**33,043**	**32,800**	**33,107**	**32,152**
Albuquerque, NM	43,426	43,161	42,924	41,998	42,586	42,613
Austin, TX	50,016	50,775	52,244	52,912	54,233	55,323
El Paso, TX	30,622	30,062	30,108	29,840	29,965	30,865
Las Vegas, NV	43,271	42,915	42,229	41,759	42,747	43,476
Portland, OR	63,221	66,055	62,654	60,811	60,549	62,229
San Antonio, TX	37,291	38,273	39,246	39,815	40,770	42,169
San Diego, CA	56,147	56,960	57,926	59,007	59,377	60,175

Source: Bureau of Economic Analysis, Real GDP by state and metropolitan area, 2009 chained dollars

Though it varies month-to-month, non-farm employment in Pima County currently sits at just over 370,000 jobs.[18] As with GDP, the region's job growth suffered considerably during the recession. In total, the region lost more than 31,000 jobs from 2008 to 2010[19] and, until recently, has been slow to return to pre-recession growth rates. Job growth has been hampered by job losses or stagnation in manufacturing, government and mining over the past five years (**Table 2.3**). Reductions in federal spending through sequestration had a disproportionate impact on the PAG region given the heavy reliance of the local economy on the government sector. Approximately 20 percent of the region's non-farm employment is in government, which is well above the national share of 15 percent.[20]

Job growth picked up somewhat in 2016. According to year-over-year employment growth data from the Arizona Office of Economic Opportunity, Tucson regional employment grew by 1.3 percent from 2015 to 2016. This represents a higher growth rate than prior years, which was in the range of 0.7 percent to 0.9 percent, though it still lagged 2016 total national job growth (1.7 percent) as well as most Western peer communities.[21]

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[17] Statistics for listed areas are at the MSA level.
[18] Arizona Department of Administration, Office of Economic Opportunity, CES Tables - Not Seasonally Adjusted Nonfarm Employment.
[19] Sun Corridor Inc., 2014 Economic Blueprint Update.
[20] Bureau of Labor Statistics, Current Employment Statistics, 2016.
[21] MAP AZ Dashboard. https://mapazdashboard.arizona.edu/economy/employment-growth-industry.

Table 2.3 Employment growth by industry, PAG region, 2011-2015 (thousands of jobs)

	2012	2013	2014	2015	2016	Percent Change 2012-2016
Total Nonfarm (avg.)	359.8	363.2	365.8	368.7	373.4	3.8%
Total Private	282.2	286.0	288.8	292.4	297.0	5.2%
Natural Resources and Mining	2.1	2.3	2.3	2.3	1.6	-23.8%
Construction	14.4	15.4	14.8	14.6	14.9	3.5%
Manufacturing	23.2	23.0	22.5	22.6	23.2	0.0%
Transportation, Warehousing and Utilities	9.8	9.5	9.9	10.3	10.1	3.1%
Retail and Wholesale	48.3	49.7	50.7	50.2	50.1	3.7%
Information	4.5	4.5	4.4	4.5	5.0	11.1%
Financial Activities	16.9	17.3	17.5	17.2	17.2	1.8%
Professional and Business Services	48.9	49.9	50.0	50.5	50.7	3.7%
Educational and Health Services	61.0	61.6	61.5	62.7	64.7	6.1%
Leisure and Hospitality	40.3	40.1	41.6	42.9	44.2	9.7%
Other Services	12.8	12.7	13.5	14.6	15.2	18.8%
Government	77.7	77.2	77.0	76.2	76.4	-1.7%

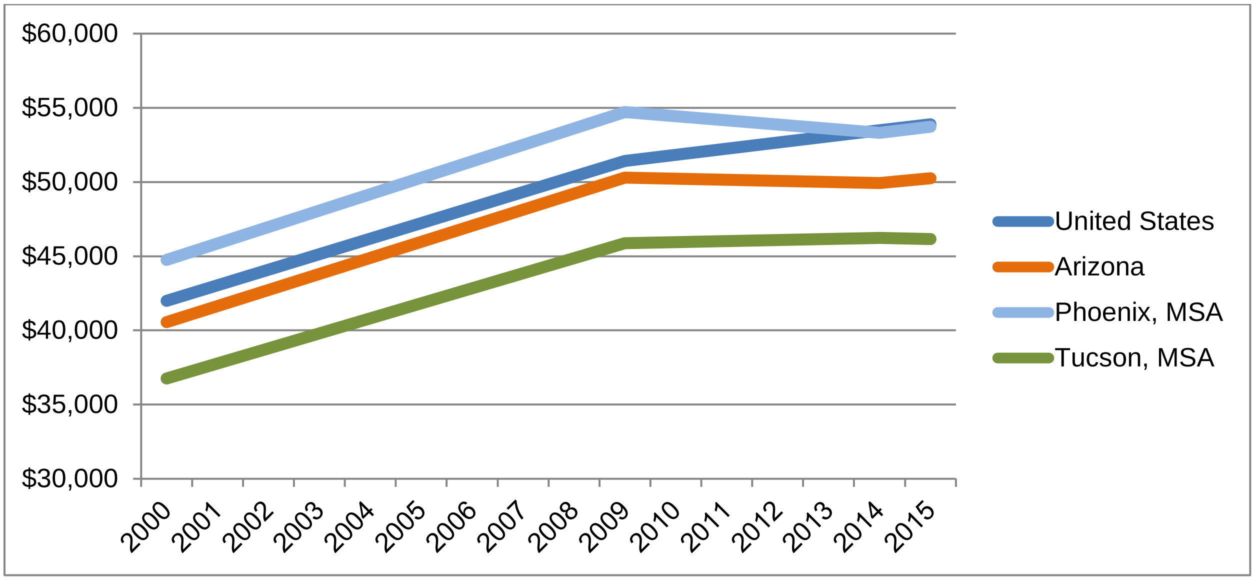
Source: Arizona Department of Administration, Office of Economic Opportunity

The PAG region has long been a lower-wage environment, with the typical worker earning about 85 percent of the U.S. average.[22] This is reflected in the regional median annual household income, which, at $46,000, is 14.5 percent below the national median and 7.7 percent lower than the rest of Arizona (**Figure 2.5**).[23] The region's payroll per employee is $38,700, which is also below most similarly sized metropolitan areas, according to the Commodity Flow Study developed for PAG with this Freight Plan.

Low regional wages can, at least in part, be attributed to the high proportion of workers in the retail, accommodation and administrative services sectors when compared with the national average. These are typically lower-paying sectors.

[22] Sun Corridor Inc., 2014 Economic Blueprint Update.
[23] MAP AZ Dashboard. http://mapazdashboard.arizona.edu/economy/median-household-income.

Figure 2.5 Median household income, 2000-2015



Source: mapazdashboard.arizona.edu

Location quotient (LQ) is a measure that can show which sectors in a region's economy employ a higher or lower share of workers than the nation. An LQ above 1 indicates that a region has a higher share of workers in a sector, while an LQ below 1 indicates a lower share of employment. **Table 2.4** shows LQs for selected sectors in the PAG region along with payroll per employee. Wholesale trade, transportation and warehousing, and manufacturing — three key freight industries with higher-than-average per-employee annual wages — are all below the national employment average in the PAG region.

It is worth noting that, while the overall LQ for the manufacturing sector is low, the LQ for the Aerospace Products and Parts subsector is above 8.5,[24] demonstrating the importance of this industry cluster. Per employee, wages for manufacturing are also about 25 percent higher than the national average because nearly half of the region's manufacturing jobs are in the high-skilled aerospace sector, primarily at Raytheon Missile Systems, the area's largest private-sector employer.

[24] Based on PAG analysis of Bureau of Labor Statistics May 2016 National Industry-Specific Occupational and Wage Estimates for Aerospace Products and Parts (NAICS 336400) and Arizona non-farm employment data (not seasonally adjusted) from the Arizona Office of Economic Opportunity.

Table 2.4 Location quotient for select sectors (private ownership), Pima County, (2016)[25]

	NAICS Code	Sector	Employment LQ	Annual Wages per Employee
Above National Share	22	Utilities	1.40	84,044
	56	Administrative and Waste Services[26]	1.30	29,281
	62	Health Care and Social assistance	1.22	44,873
	72	Accommodation and Food Service	1.15	18,464
	21	Mining, Quarrying, and Oil and Gas Extraction	1.05	74,357
	53	Real Estate and Rental and Leasing	1.05	40,326
	44-45	Retail Trade	1.05	28,276
Below National Share	23	Construction	0.88	42,283
	54	Professional and Technical Services	0.84	65,994
	31-33	Manufacturing	0.74	83,200
	52	Finance and Insurance	0.71	61,606
	48-49	Transportation and Warehousing	0.63	42,751
	42	Wholesale Trade	0.51	59,430
	55	Management of Companies and Enterprises	0.34	54,411

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages

With relatively low levels of economic activity, low wages, overdependence on public spending and high vulnerability to economic downturns, the region recognizes the importance of diversifying the local economy, emphasizing export-based industries and building on regional strengths in advanced manufacturing. These industries, by their nature, are heavily reliant on the freight network for building successful businesses, which is why ensuring the smooth movement of goods is so important to the region's future.

The next section of the Freight Plan looks in more detail at the PAG region's freight-intensive industries, particularly those that export.

[25] For a more detailed subsector list, visit https://data.bls.gov/cew/apps/data_views/data_views.htm.
[26] Includes call centers, landscaping, janitorial services, job placement services, security services and others.

Freight-Intensive Industries

Freight-intensive industries include those businesses that import or export goods to sustain their daily operations and generate profits. These industries include the following:

- agriculture
- mining
- manufacturing
- construction
- wholesale
- retail
- transportation
- warehousing

Taken together, these industries directly account for roughly 25 percent of the region's employment and over 29 percent of GDP (**Table 2.5**), a share which is lower than many similar-sized regions.

Table 2.5 Freight-intensive industry employment and GDP (2015)

	Employment		GDP	
Industry	**Number of Jobs**	**Share of regional jobs**	**Value** (millions of current dollars)	**Share of regional GDP**
Agriculture	1,394	0.3%	66	0.2%
Mining	4,454	0.9%	1,331	3.7%
Manufacturing	24,689	4.9%	3,569	9.9%
Construction	22,083	4.4%	1,077	3.0%
Wholesale	10,116	2.0%	1,081	3.0%
Retail	51,756	10.3%	2,608	7.2%
Transportation and Warehousing	12,085	2.4%	886	2.4%
Total	**126,557**	**25.2%**	**10,618**	**29.4%**

Source: Bureau of Economic Analysis[27]

[27] Employment data derived from BEA table CA25N - Total Full-Time and Part-Time Employment by NAICS Industry for the Metropolitan Statistical Area. This dataset includes both wage/salary jobs as well as proprietors/self-employed. The data presented in Table 2.3 excludes proprietors/self-employed, thus accounting for some of the difference in total employment numbers.

While all the industries listed in **Table 2.5** rely on the region's freight transportation network, each has different needs and supply-chain characteristics. The following section provides a brief overview of these freight-dependent industries, apart from agriculture, which employs far fewer people relative to other industries on the list. As such, no further analysis was deemed necessary.

Pima County's economy is largely dependent on the public sector, particularly the education and defense sectors, but many regional businesses also are dependent on freight transportation. Businesses within the freight-dependent industries listed above use the regional transportation system to receive materials to produce their goods and to then transport their goods to market. **Figure 2.5** illustrates the significance of goods-dependent or freight-dependent industries to GDP and employment in Pima County. The economic health of these industries — and, to some extent, the broader economy — is reliant upon the safety and efficiency of the freight transportation system.

Analyses by both PAG and transportation-infrastructure consulting firm CPCS indicate that trucks are the dominant mode across all freight-intensive industries. Rail is used primarily by mines and the construction industry to transport heavy raw or bulk materials that are relatively low in value. Industries that depend on timely delivery of high-value/low-weight commodities, such as advanced manufacturing, typically use truck or air for delivery needs. For a detailed analysis of regional commodity flows, please refer to the Commodity Flow Report in **Appendix 1**.

Retail (NAICS 44-45)

The retail trade sector represents a broad spectrum of the economy, ranging from individual proprietors to big-box retailers, with many retailers related to travel and tourism. According to the Bureau of Labor Statistics (BLS), the retail trade sector consists of businesses that engage in the retailing of merchandise, generally without transformation, and the rendering of services that accompany the sale of said merchandise.[28]

The PAG region has a high proportion of service-industry retail and non-retail service jobs, which are driven by the tourism economy as well as the above-average proportion of resident retirees. Retailers catering to this service-focused demographic rely heavily on the freight transportation system to complete the supply-chain cycle from manufacturer to distributor to retailer. These shipments may often be lighter-weight, higher-value goods moved by truck as less-than-truckload (LTL), parcel or air.

In recent years, seismic shifts in consumer purchasing habits have significantly altered the retail landscape. With the rapid rise of e-commerce giants, such as Amazon, online

[28] Bureau of Labor Statistics. (2017). Industries at a Glance. Retrieved from https://www.bls.gov/iag/tgs/iag44-45.htm.

sales are creating substantial changes to supply chains and inventory management strategies. As online shopping captures a larger market share, the amount of consumer travel associated with shopping trips is decreasing. Conversely, the amount of truck traffic in urban areas is increasing as goods are delivered directly to consumers' doorsteps. In response to e-commerce and other market trends, brick-and-mortar stores now maintain lower in-store inventories to save costs and have shifted to just-in-time delivery (acquiring product only as demand requires) rather than carrying excess inventory. In doing so, retailers avoid "stock-outs," or not having a product available when a customer wants it. Stock-outs are commonly reported as the biggest single concern among retailers. All the above-mentioned retail sector trends have led to a greater dependence on the reliability of the freight transportation system to deliver smaller quantities of goods in a timely manner. Moreover, retailers of perishable products face the challenge of transporting products with finite shelf lives and the risk of spoilage.

Top Five Regional Retail Sector Employers and Number of Employees, PAG Region

Employees	*Employer*
4,260	Walmart
2,790	Fry's Food & Drug Stores Inc.
1,420	Safeway Inc.
1,250	Target Corp.
910	Jim Click Automotive Group

Source: 2016 MAG Employer Database, employers with five or more employees.

Manufacturing (NAICS 31-33)

The manufacturing sector is a major contributor to the regional economy and produces the largest number of private-sector jobs. The BLS defines the manufacturing sector as establishments engaged in the mechanical, physical or chemical transformation of materials, substances or components into new products. Establishments in the manufacturing sector are often described as plants, factories or mills, and characteristically use power-driven machines and materials-handling equipment.[29]

The PAG region's manufacturing sector is dominated by advanced manufacturing companies — such as Raytheon Missile Systems, Ventana Medical Systems, IBM and Honeywell — with highly skilled employees. These companies lead in producing goods that are consumed outside the region, bringing wealth into the community and supporting economic growth in other business sectors and industries. The largest private employer in the region by a significant margin is Raytheon, which currently employs more than 10,500 people in Tucson, where it operates the largest, most sophisticated missile production system in the world. According to the W.P. Carey

[29] Bureau of Labor Statistics. (2017). Industries at a Glance. Retrieved from https://www.bls.gov/iag/tgs/iag31-33.htm.

School of Business at Arizona State University, Raytheon's annual economic impact in Arizona is valued at more than $2 billion.

Given the sensitive nature of Raytheon's product offering, most of its freight movements are kept classified. Finished goods from the other major manufacturers are transported primarily by truck. Some finished goods, such as precision instruments and other high-value or time-sensitive products, are shipped by air from Tucson International Airport or Phoenix Sky Harbor International Airport.

Top Five Manufacturing Sector Employers and Number of Employees, PAG Region

Employees	*Employer*
10,590	Raytheon Missile Systems
1,400	Ventana Medical Systems
1,050	IBM
740	Honeywell
640	Rockwell Collins

Source: 2016 MAG Employer Database, employers with five or more employees.

Wholesale (NAICS 42)

The "other half" of the retail trade sector, the wholesale trade sector, is fundamental in orchestrating the movement of goods, both durable and non-durable, from manufacturer to retailer. According to the BLS, the wholesale trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The wholesaling process, then, is an intermediate step in the distribution of merchandise.[30]

Top Five Wholesale Sector Employers and Number of Employees, PAG Region

Employees	*Employer*
400	Dependable Home Health Inc.
240	R & R Products Inc.
220	Golden Eagle Distributors Inc.
150	Finley Distributing LLC.
110	Manheim Tucson

Source: 2016 MAG Employer Database, employers with five or more employees.

Durable goods wholesalers are organized to sell or arrange the purchase or sale of durable goods, such as motor vehicles, furniture, construction materials, machinery and equipment (including household-type appliances), metals and minerals (except petroleum), sporting goods, toys and hobby goods, recyclable materials and parts. Non-durable goods, on the other hand, are items with a life expectancy of less than three years, such as paper products, chemicals and

[30] Bureau of Labor Statistics. (2017). Industries at a Glance. Retrieved from https://www.bls.gov/iag/tgs/iag42.htm.

chemical products, drugs, textiles and textile products, apparel, footwear, groceries, farm products, petroleum and petroleum products, and alcoholic beverages.

Transportation and Warehousing NAICS (48-49)[31]

The transportation and warehousing sector, which is by its nature freight-dependent, primarily consists of activities providing transportation of passengers and cargo, and the warehousing and storing of goods. For establishments in this sector, transportation equipment and/or transportation-related facilities serve as a productive asset essential to operations. The regional modes of transportation used by this sector are air, rail, road and pipeline. With Tucson's prime, advantageous location along I-10, one of only three coast-to-coast interstates in the country, and its proximity to Mexico, the region has the collective assets to successfully compete as a center for transportation and warehousing business.

In recent years, two major distribution centers have opened in Tucson: the Target.com Fulfillment Center and the HomeGoods Distribution Center. Both warehouses are approximately 1 million square feet, and together they employ more than 1,500 people. As with other e-commerce retailers, the Target.com Fulfillment Center is part of a growing logistics chain that moves goods directly to consumers through multiple channels, including online, catalogs, brick-and-mortar stores and more. The HomeGoods facility currently services nine Western states and receives shipments directly by truck and transloaded containers by rail via the Port of Tucson. The facility came online to alleviate issues with supply and congestion at the Long Beach distribution center. The company expects Tucson's volume will continue to increase — even double — as the fulfillment center is assigned more stores or as more stores are built.

Top Five Transportation and Warehousing Sector Employers and Number of Employees, PAG Region

Employees	*Employer*
840	U.S. Postal Service
750	Bombardier
550	HomeGoods Inc. Distribution Center
400	Target.com Fulfillment Center
380	FedEx

Source: 2016 MAG Employer Database, employers with five or more employees.

[31] HomeGoods employment data provided through an interview with a company representative. FedEx count includes FedEx Ground, Air and Freight.

Construction (NAICS 23)

In Pima County, the construction sector is made up of establishments engaged in the construction of buildings and other structures (including additions); heavy construction other than buildings; and alterations, reconstruction, installation, and maintenance and repairs. The sector is further subdivided into three categories:

- Construction of Buildings (e.g., residential, commercial and industrial),
- Heavy and Civil Engineering Construction (e.g., utility systems, land subdivision, highway, streets and bridges)
- Special Trade Contractors (e.g., electrical, plumbing, heating and air conditioning)[32]

Materials used in construction include gravel, sand, building stone, lumber, ready-mix concrete and asphalt. Most of these products move by truck from quarries around Pima County to the construction site and tend to move from the nearest source because of their bulkiness, weight and cost of transport. The raw materials used in construction are relatively low in value on a per-ton basis, so shorter movements are preferred, as transportation can account for 50 percent or more of the total landed cost of the product. For perishable loads, such as Portland cement, the delivery window is approximately 90 minutes, which requires logistical planning when sourcing and for off-peak delivery times.

Over the past decade, the health of the construction sector has fluctuated greatly. With the Great Recession of 2008, there was a significant decline in the number of construction projects and, subsequently, the need for materials. The construction sector's outlook has improved in recent years, mostly due to a strengthening residential market and some major construction projects, but will likely not reach pre-recession levels in the foreseeable future.

Top Five Construction Sector Employers and Number of Employees, PAG Region

Employees	*Employer*
270	Environmental Earthscapes Inc.
200	Sun Mechanical Contracting Inc.
180	Borderland Construction Co. Inc.
165	Granite Construction
160	The Ashton Co. Inc.

Source: 2016 MAG Employer Database, employers with five or more employees.

[32] North American Industry Classification System (NAICS) (online) U.S. Census Bureau. (2017). Retrieved from http://www.census.gov/eos/www/naics/.

Mining (NAICS 21)

The mining sector comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well operations, beneficiating (e.g., crushing, screening, washing and flotation), and other preparation customarily performed at the mine site or as a part of mining activity.[33] Mining is a major contributor to the state and regional economy due to abundant natural resource reserves.

As the first of Arizona's "Five Cs" (copper, cattle, cotton, citrus and climate), copper is the state's most valuable mineral commodity and a major economic driver.[34] Copper is closely tied to economic growth, as it is a key component of energy, aerospace, transportation and telecommunications systems throughout the world. In southern Arizona, two major mining companies dominate the market for copper production: Freeport-McMoRan and American Smelting and Refining Co. (ASARCO). Collectively, the large-scale regional mining operations of these two companies produce an estimated 60 percent of the nation's copper and thousands of tons of precious metals each month. The direct and indirect economic impact of mining across Arizona is estimated at $3.5 billion annually.[35] Molybdenum, an important byproduct of copper mining, is also produced in the region.

The copper mining operations in Pima County use both rail and truck to move product. A significant amount of the mined copper and its byproducts (concentrate, cathode, sulfuric acid) are transported by truck to smelters in Gila County in Arizona or refineries in West Texas. Due to the limited output capacity of Arizona smelters, however, some concentrate is shipped by rail and truck to the Port of Guaymas, Mexico, and destined for overseas markets in Europe and Asia. The Port of Guaymas is currently the only port shipping Arizona copper concentrate overseas. In general,

Top Five Mining Sector Employers and Number of Employees, PAG Region

Employees	*Employer*
970	Freeport-McMoRan
820	ASARCO
250	Modular Mining Systems Inc.
170	Hexagon Mining
34	Vulcan Materials Co.

Source: 2016 MAG Employer Database, employers with five or more employees.

[33] North American Industry Classification System (NAICS) (online) U.S. Census Bureau. (2017). Retrieved from http://www.census.gov/eos/www/naics/.

[34] Arizona State Library, Archives & Public Records, The 5 Cs at http://www.azlibrary.gov/arizona-almanac/five-c.

[35] The Arizona Geological Survey. Mining and the 21st Century Arizona Economy. http://www.azgs.az.gov/minerals_mining.shtml.

truck is the preferred mode in time-sensitive situations, while rail is generally less costly. The distance between origin and destination also can be a significant factor in modal choice due to cost considerations.

Freight-Intensive Land Use

Freight flow patterns for goods originating or terminating in the PAG region are largely determined by the location and intensity of businesses that send or receive freight. Manufacturers, mines, distribution centers and retailers all generate freight traffic on the region's roadways. The location of these businesses is, in turn, primarily determined by the land use regulations of the region's jurisdictions.

One of the key freight-dependent land use categories is industrial land. Industrial lands include not only manufacturing but also other freight-related uses, such as warehousing. The region contains an abundance of industrial-zoned land with quick access to the interstate, where many of Tucson's export-generating and warehousing operations are located. Significant industrial employment centers are located near Davis-Monthan Air Force Base (DMAFB), on the southeast side of Tucson; near Tucson International Airport (TUS); and along I-10 between Marana and Tucson on the northwest side of the region.

The industrial area west of DMAFB is largely developed with a mix of small manufacturing, retail, warehouses, salvage yards and other freight-generating businesses. The Union Pacific Tucson Classification Yard, the Kinder Morgan Tucson Terminal and, further to the east, Tucson Electric Power's H. Wilson Sundt Generating Station are in this general area.

Southeast of DMFAB, following roughly along Valencia Road, from Wilmot Road to Houghton Road, is another cluster of industrial land. The area presents an increasingly important high-tech industry cluster and transportation hub for logistics-focused businesses. The University of Arizona Tech Park at Rita Road is a research park focusing on high-tech industries, and the Port of Tucson is the region's truck-to-rail intermodal facility, the only intermodal facility in Arizona certified for direct delivery and origination of international containers.[36] A considerable amount of vacant developable land is available in the area.

The third major industrial and business development area is located south of TUS, between I-10 and I-19. This area, which includes the Aerospace Research Campus (ARC), is home to an emerging aerospace cluster anchored by Raytheon Missile Systems. The ARC, according to a pamphlet released by the Pima County Economic Development office, "is the initial portion of a larger planned industrial park. Combined

[36] Pima County Economic Development Plan, Chapter 4 Page 1.

with Tucson Airport Authority and Arizona State Trust Land, there will be over 2,400 acres available for development."[37]

In addition to the aerospace cluster, the area near TUS also was identified as a prime opportunity area for import and distribution in both JPAC's *Freight Transportation Framework Study* and Pima County's *Economic Development Plan.*[38] The co-location of freight rail, two interstates and an air cargo facility make this an ideal location for staging and distribution of goods flowing from Mexico and for serving as a logistics hub for freight moving between major Southwestern markets. Logistics activity has begun to pick up in the area with the recent openings of a HomeGoods distribution center, a FedEx Ground distribution center and an Old Dominion Freight Lines facility, all on Corona Road between South Country Club Road and South Alvernon Way.

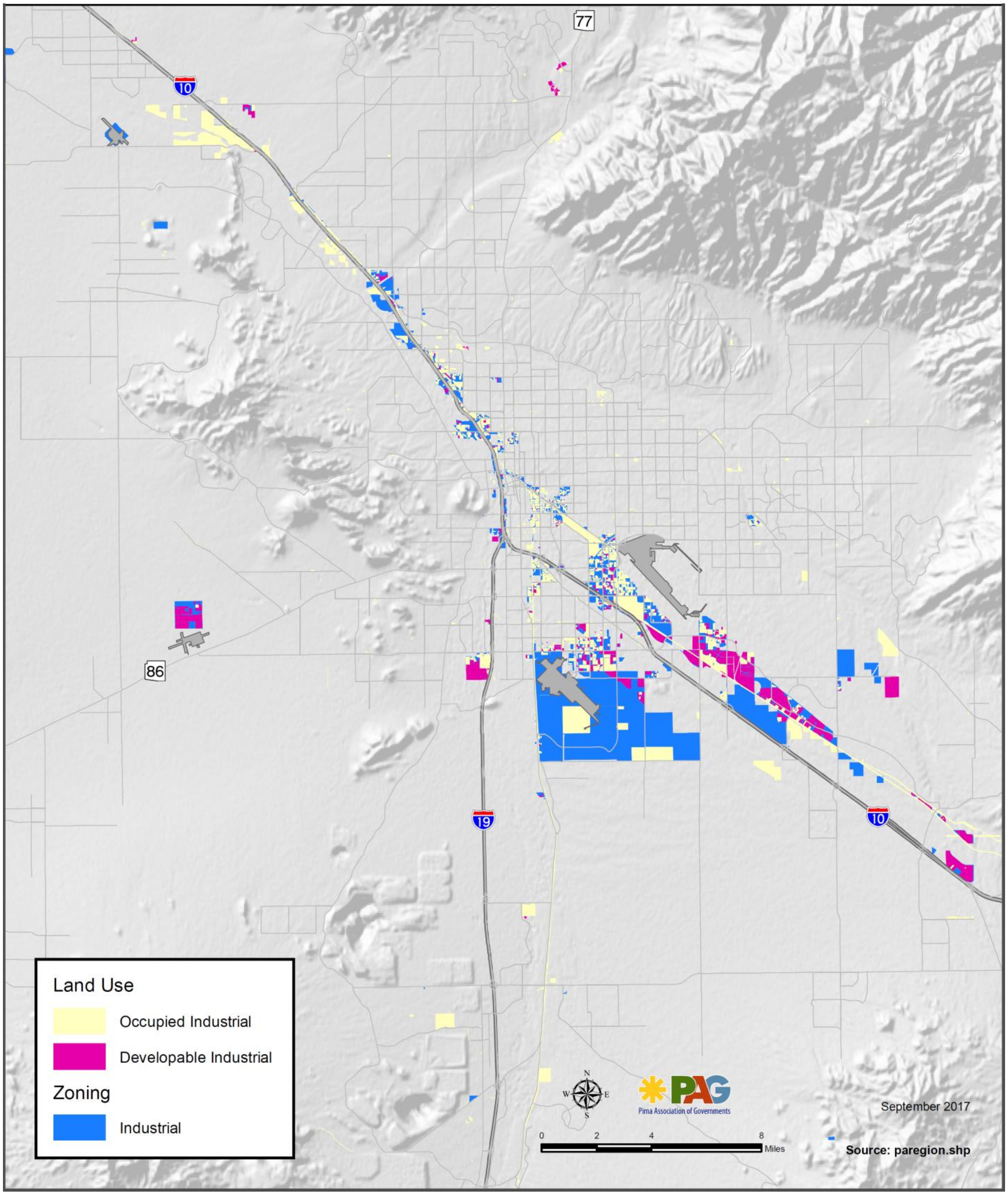
Other industrial and warehousing areas are located along I-10 from Grant Road to Prince Road and farther north around Ina Road, Avra Valley Road (including the CalPortland plant) and a few other locations.

Currently, Pima County has more than 13,000 acres of occupied industrial land. Another 6,700 acres of industrial land are vacant and developable. The number of vacant acres does not account for parcels that are zoned industrial but are not currently under an industrial land use. When these industrially zoned parcels are factored in, the amount of available industrial land increases considerably, particularly near Tucson International Airport. The location of industrial uses and industrially zoned land is shown in **Figure 2.6**. Occupied and vacant industrial land is presented with industrially zoned land to show where current industrial activity occurs and where capacity exists for future development.

The distribution of freight-generating activity can be illustrated by showing the location of larger freight-intensive businesses (20+ employees). **Figure 2.7** shows the location of larger freight intensive businesses in the region. Note that retail/wholesale businesses are distributed throughout the region — typically along major arterial roadways — while transportation, warehousing, logistics and manufacturing are largely clustered near the interstates, around TUS, and near DMAFB. A notable exception is the manufacturing activity near Tangerine Road and Oracle Road in the Town of Oro Valley. This area is known as Innovation Park, and it is home to major research campuses as well as manufacturing operations for Sanofi, Ventana Medical Systems, Securaplane Technologies Inc. and others. Honeywell Aerospace is located southeast of Innovation Park on Oracle Road.

[37] Aerospace Research Campus. http://www.suncorridorinc.com/SunCorridor/media/Sun-Corridor/Documents/Sites%20and%20Data/ARC.pdf.
[38] Pima County Economic Development Plan. 08/2015. https://webcms.pima.gov/cms/One.aspx?pageId=183160.

Figure 2.6 Industrial land uses and industrially zoned lands in eastern Pima County (2017)[39]



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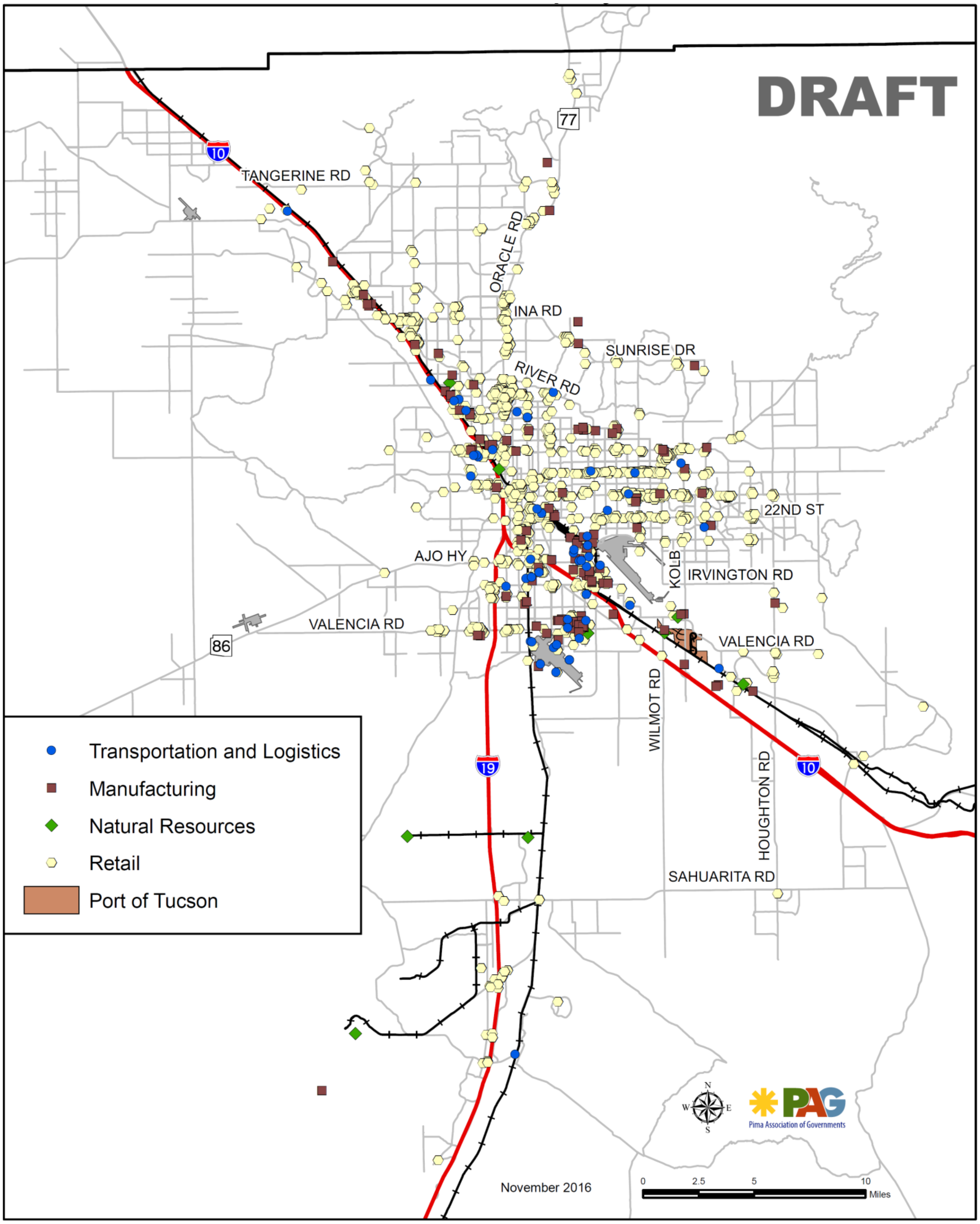
[39] Industrial zoning was aggregate by PAG based on zoning classifications submitted by the region's jurisdictions and maintained by Pima County. Land use was derived from parcel use data from the Pima County GIS Library: http://gis.pima.gov/data/contents.

Figure 2.7 Current freight-intensive employers with 20+ employees, PAG region (2016)



Source: PAG analysis of InfoUSA employment data

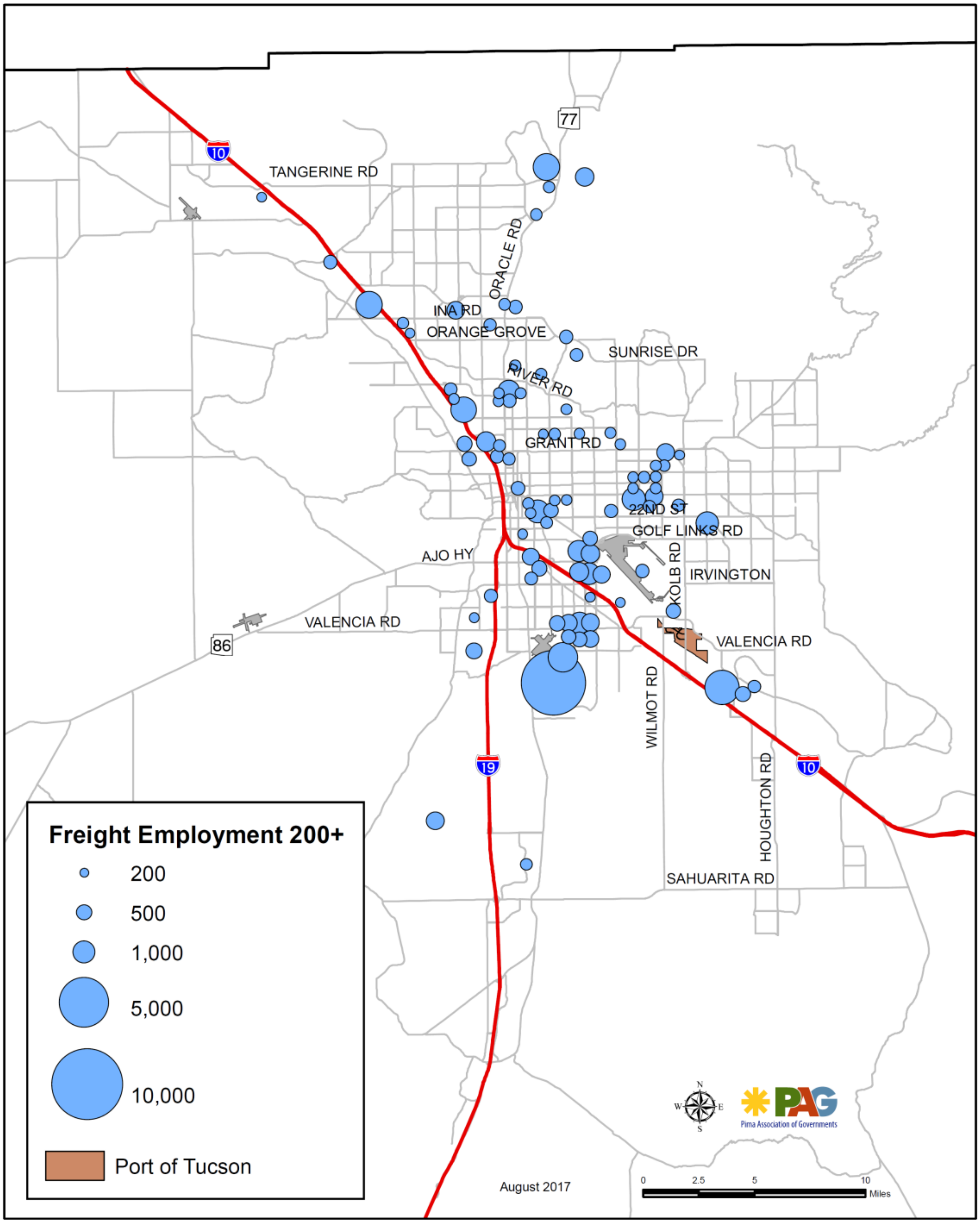
Another way of looking at freight-intensive activity levels is to aggregate employment at the traffic analysis zone (TAZ). TAZs are basic spatial units of analysis facilitating the ability of transportation planners to forecast changes in commuting patterns, trip volumes and modes of travel, and to develop plans to meet the changing demands for transportation facilities and capacities. Each TAZ represents an area containing similar kinds of land use and commuter travel. Aggregating employment by TAZ provides a comparative view of where freight-intensive industry employment is most concentrated, without regard for specific business locations. In addition, it provides a rough proxy for predicting where freight activity is occurring and demonstrates where freight is supporting the most regional jobs. **Figure 2.8** shows freight-intensive employment in the region. The map does not show the precise location of businesses but instead shows the relative number of jobs in each TAZ marked at the center point. Retail has been excluded from the map for the purposes of simplicity and focusing on export-oriented industries.

In addition to zoning, current land use and freight employment intensity, the Freight Plan also considers which TAZs are producing the most tonnage and value of goods; this is a more direct measure of freight generation than employment. To gain a better understanding of what's moving in the region, PAG acquired 2013 TRANSEARCH data from IHS Global Insight Inc. This is the same dataset used by ADOT to develop the Arizona State Freight Plan and which provides the base data for the Commodity Flow Report found in **Appendix 1**. The TRANSEARCH data identify the specific commodities that are generated and delivered to Pima County, as well as show which of the region's TAZs are receiving or generating the most freight by value and tonnage. For more information about commodity flows, see the complete Commodity Flow Report in **Appendix 1**.

Figure 2.9(a) illustrates which TAZs in eastern Pima County are generating and receiving the most freight by value. These are the locations that, either through sheer volume of goods moved or because the goods being transported are high-value commodities, generate considerable economic activity for the region. The outbound freight value map shows where the region's traded goods sector is strongest.

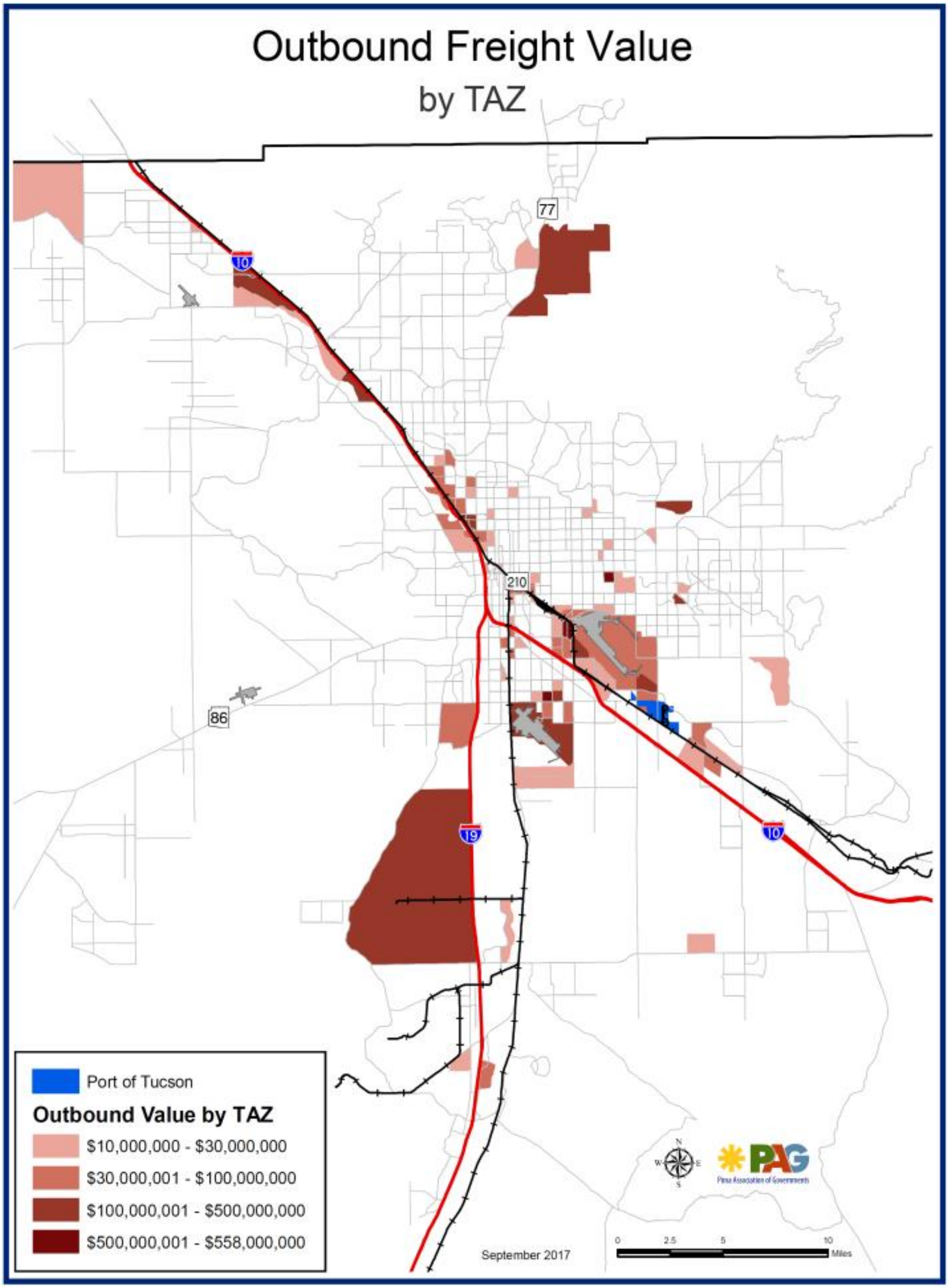
Figure 2.9(b) shows which TAZs are generating and receiving the greatest freight tonnage. High-tonnage generating TAZs are often, though not always, locations that are sending or receiving high-weight and low-value basic products, such as stone and rock for construction or scrap metal. These commodities may account for significant truck volumes but less economic impact per unit than higher value-added commodities, such as precision instruments.

Figure 2.8 Current freight-intensive employment by TAZ (excluding retail) (2016)



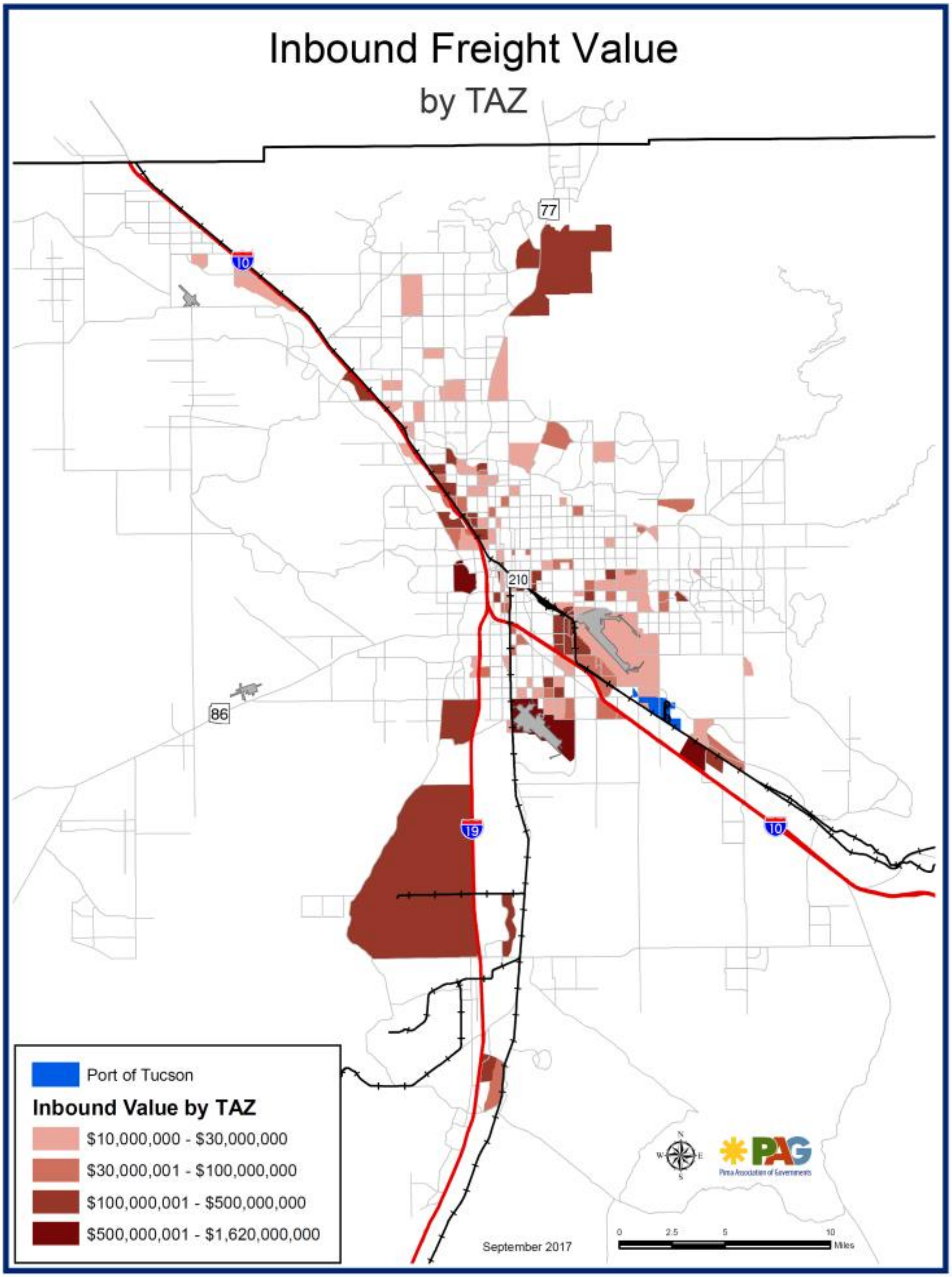
Source: PAG analysis of InfoUSA employment data

Figure 2.9(a) Outbound freight value by TAZ (truck only)



Source: PAG Analysis of TRANSEARCH

Figure 2.9(b) Inbound Freight Value by TAZ (truck only)



Source: PAG Analysis of TRANSEARCH

Figures 2.9(a), 2.9(b), 2.10(a) and 2.10(b) account only for goods moving by truck. Freight rail data are not available at the TAZ scale from data sources used for the Freight Plan. This explains why the Freeport McMoRan Sierrita mine complex is not represented on the map, as the source data assume copper and other metals coming from the Sierrita operation are moved predominantly by rail. The ASARCO Mission complex copper mine, west of I-19 near Sahuarita, features prominently on both value and tonnage maps.

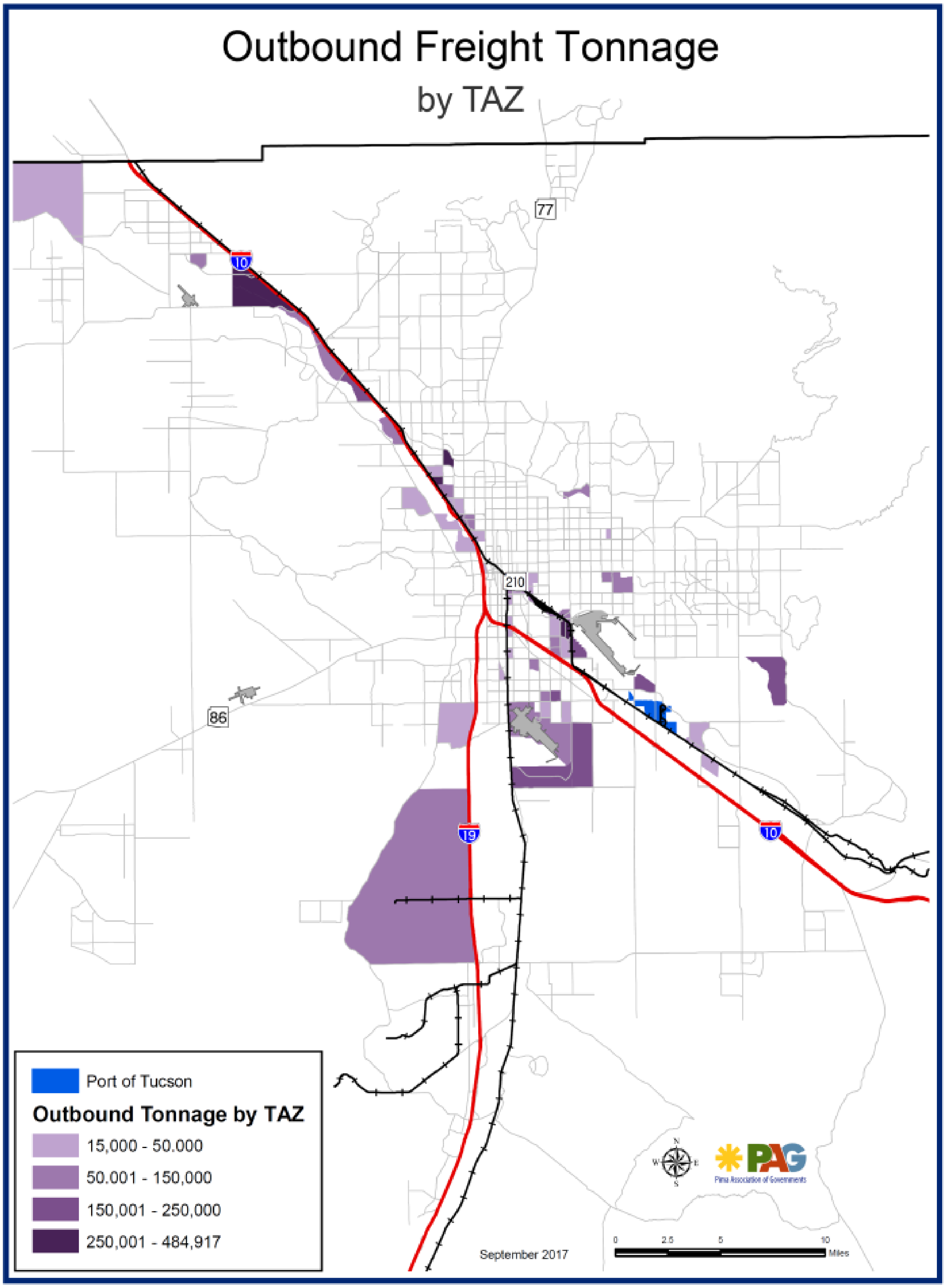
The TAZs generating and receiving the most freight correspond closely to the locations of freight-intensive employment clusters and freight-intensive businesses. Since these data are generated from separate sources, the maps provide independent data validation and better understanding of the region's freight economy.

Based on current long-range land use plans, it is anticipated that the same locations will continue to be the primary freight generators in the region over the next 20 to 25 years. The proximity of critical freight-supportive infrastructure, the PAG region's position within global supply chains, availability of industrially zoned lands, and supportive incentives, policies and economic development districts should all provide opportunities for expansion of freight-generating industries into the future.

Figure 2.11 shows a projection of where future freight-intensive employment is anticipated to be concentrated. The map is based on the outputs from PAG's land use model, which takes future employment projections and distributes the jobs throughout the region. This is based on available land and future land uses identified in jurisdictional general and comprehensive plans.

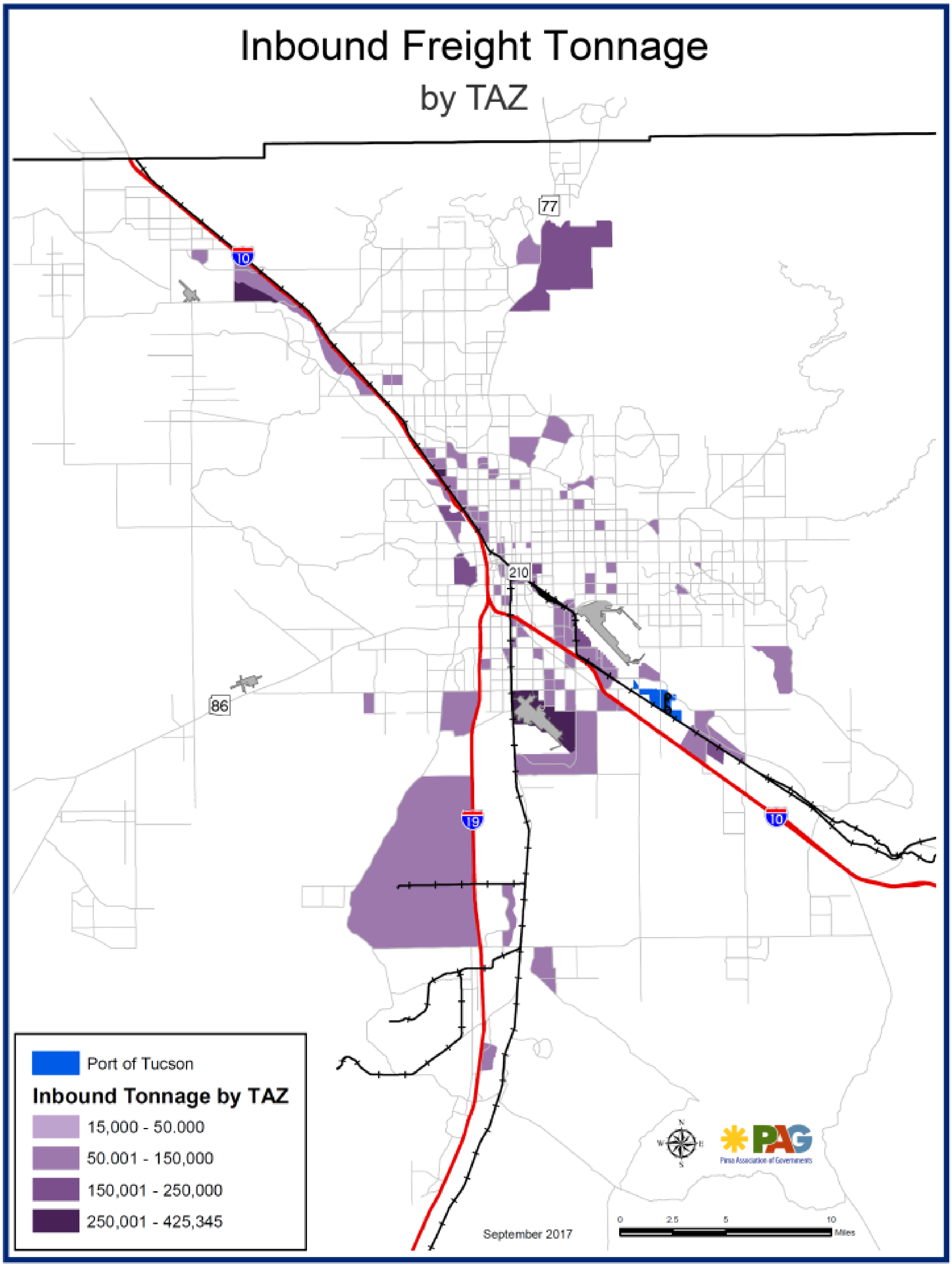
The PAG region's location presents considerable opportunities for retaining and recruiting export-focused companies and establishing the region as a logistics hub for the Southwest. Southern California, representing a market of 23 million people for Tucson's goods, can be reached within a single day; the Phoenix metropolitan region, Tucson's largest current trading partner, is a short distance north on I-10; and the major Texas markets to the east are some of the fastest-growing and largest economies in the United States.

Figure 2.10(a) Outbound Freight Value by TAZ (truck only)



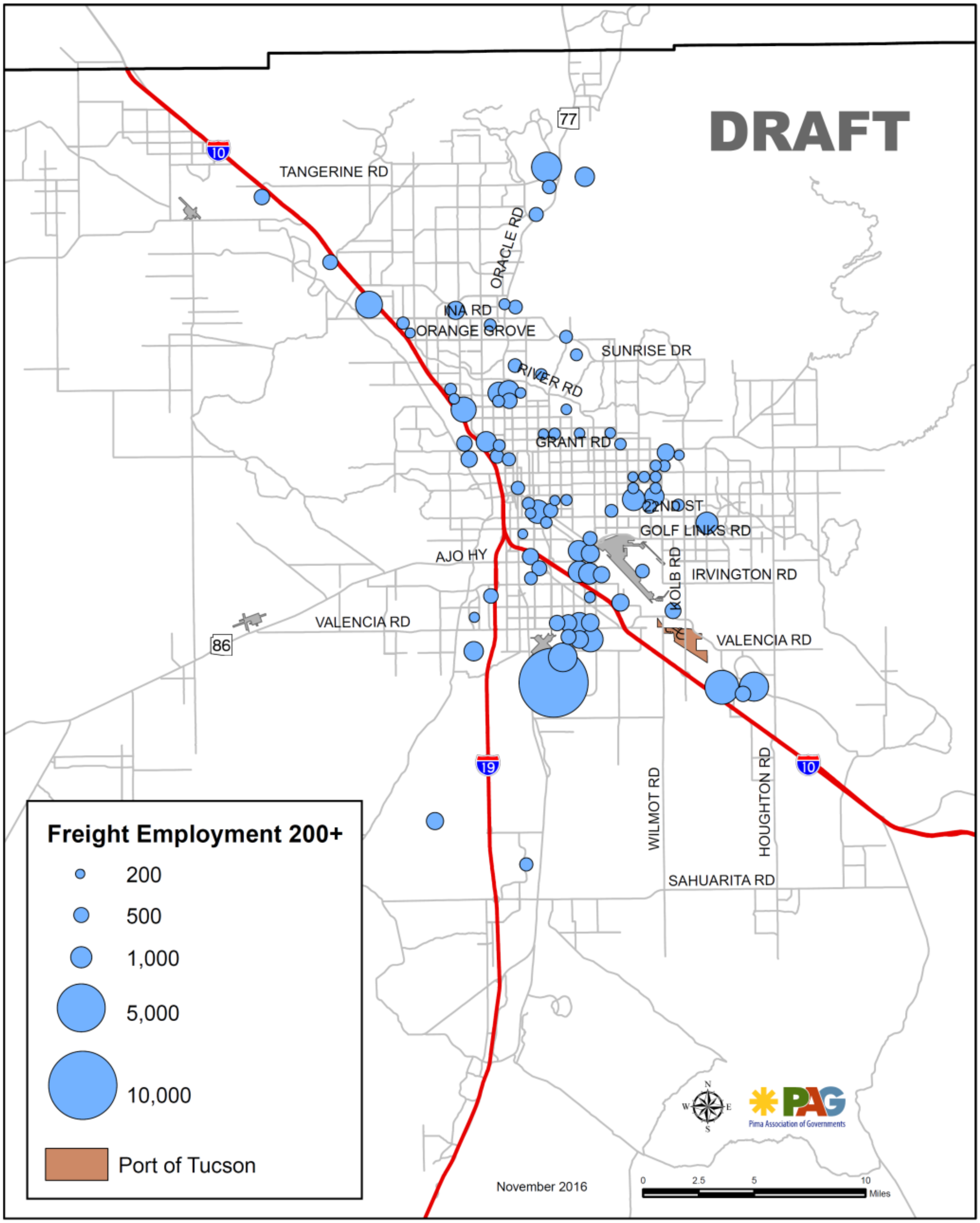
Source: PAG Analysis of TRANSEARCH

Figure 2.10(b) Inbound Freight Value by TAZ (truck only)



Source: PAG Analysis of TRANSEARCH

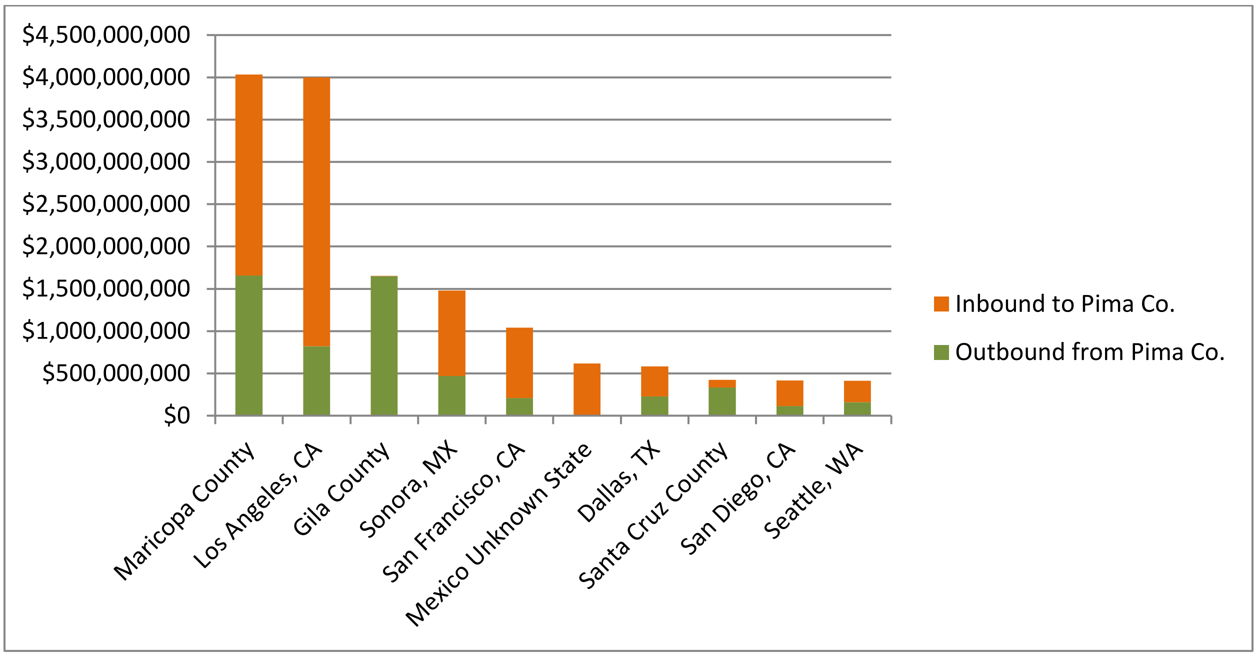
Figure 2.11 Freight-intensive employment by TAZ (excluding retail) (2045)



Source: PAG land use model based on existing jurisdiction plans

Proximity to the border provides access to another nearly 14 million consumers in northwestern Mexico. It also supports manufacturing and supply-chain partnerships, given the presence of a skilled workforce and the lower production costs for many goods. **Figure 2.12** shows Pima County's top trading partners based on total value of freight flows moving between the regions. Pima County's top six trade relationships are with regions in California, Mexico or Arizona, the strongest relationships being with Maricopa County and the Los Angeles metropolitan region. Gila County is the only region of this group that receives more goods from Pima County than it sends. This is due to copper products from Pima County being shipped to Gila County for processing.

Figure 2.12 Pima County top metropolitan area trading partners (2013)[40]



Source: CPCS analysis of TRANSEARCH

Summary

Because of Tucson's heavy dependence on the service sector and non-central location relative to many important national supply chains, the region trails many comparable regions regarding freight employment. One exception is strength in advanced manufacturing, mostly related to the aerospace and defense sector (though the outsized importance of Raytheon to the local economy presents its own risks).

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[40] Note: Data exclude $6.7 billion in missile or space vehicle parts, Pima County's top outbound commodity by value, due to destination market not being available in the commodity flow data.

As land costs increase in many of the larger metropolitan areas, and worsening congestion negatively affects freight reliability in the West's largest cities, the PAG region could become a more attractive alternative for the production and distribution of goods across the Southwest, particularly given the high availability of developable industrial lands. This would help to expand the economy of the region and raise wages for workers. (For a more detailed discussion about Tucson's relative position vis-à-vis freight, see the Commodity Flow Study prepared as part of this Plan and presented here as **Appendix 1**.)

This chapter has shown areas where most freight is currently generated in the region. The corridors connecting those areas to the interstate system are critical for supporting goods-producing industries and exporters.

The next chapter describes the existing conditions of the region's freight-supporting transportation infrastructure, with a focus on corridors that connect to major freight generators.

3

Freight Infrastructure Profile

3. Freight Infrastructure Profile

The PAG region's multimodal transportation system is the foundation on which goods travel to market, playing a critical role in regional commerce and economic growth. This chapter examines the operating characteristics of the freight transportation system.

Overview

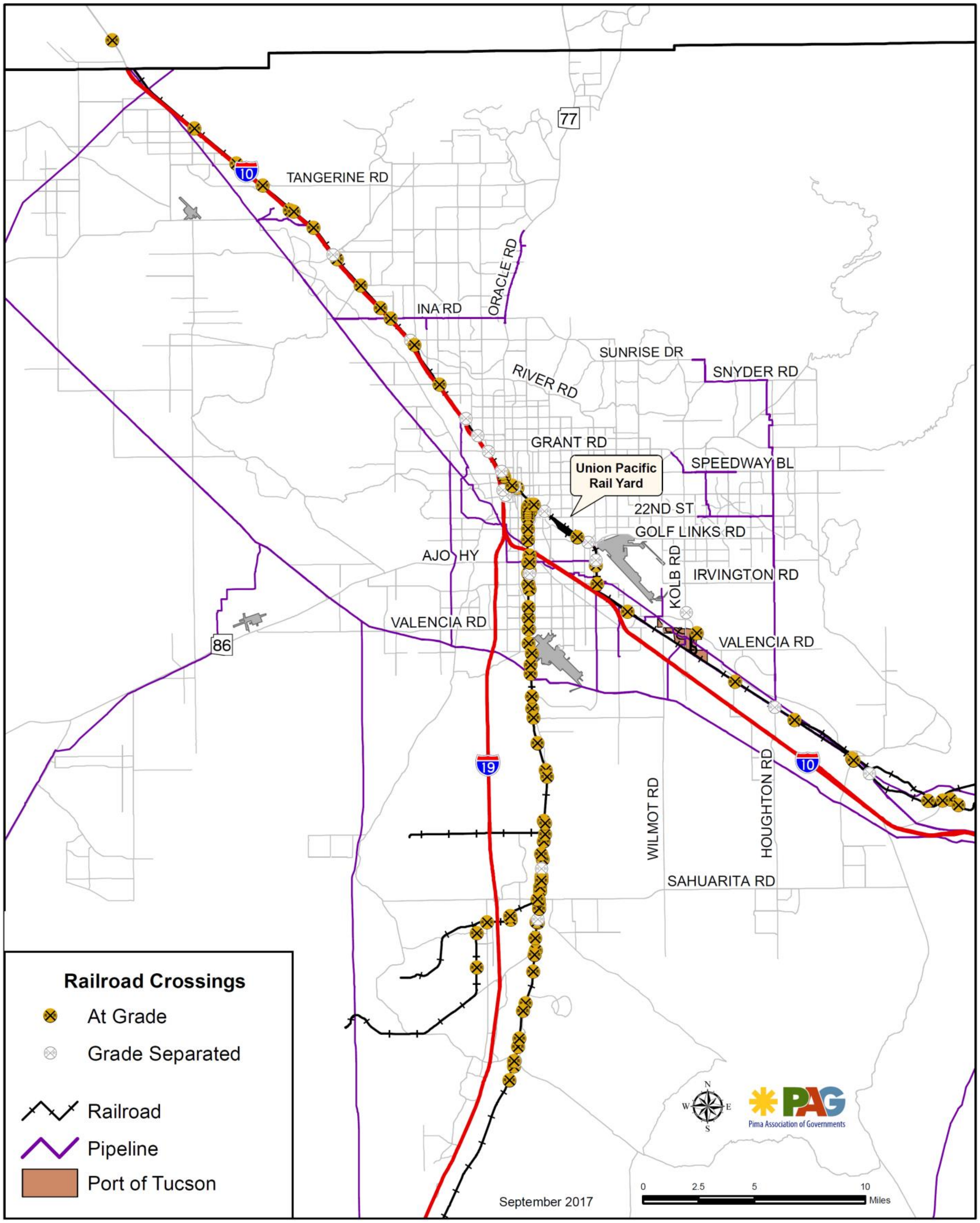
The region's freight system comprises two major interstates, the arterial roadway system, a Class I railroad and rail classification yard, three airports, a gas and petroleum interstate pipeline and terminal, and a truck-to-rail intermodal facility (**Figure 3.1**). Few regions of similar size can boast this collection of infrastructure assets, combined with easy border access, contributing to the economic vitality of this unique geographic location. In terms of trade and goods movement, the PAG region is located at a freight junction of potential national and international importance, though the region has yet to fully capitalize on this potential.

The Roadway Network

Trucking is the dominant mode for freight movement in the region. In 2013 alone, the most recent year for which data are available, over 61 million tons of goods worth over $173 billion moved on the region's roadways.[41] Eighty-four percent of freight (by value) destined for Pima County travels by truck, while 65 percent of outbound freight (by value) from Pima County travels by truck.[42]

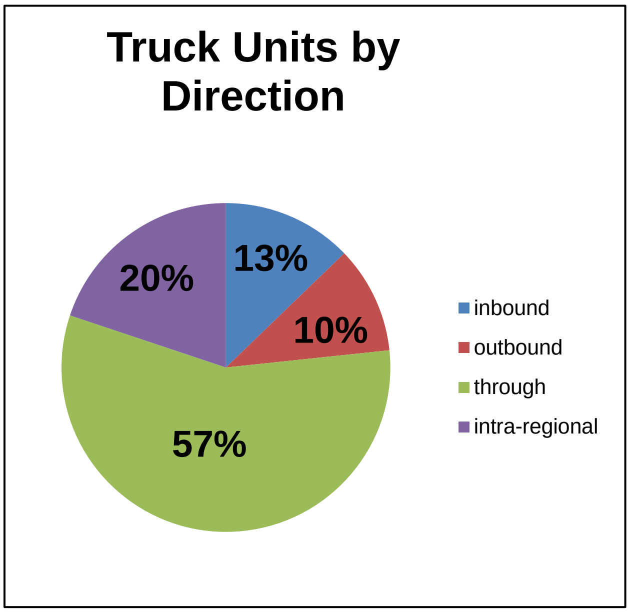
[41] CPCS. Commodity Flow Study Draft Final Report. Prepared for Pima Association of Governments. 2017. Findings based on analysis of IHS Global Insights TRANSEARCH data.
[42] Ibid.

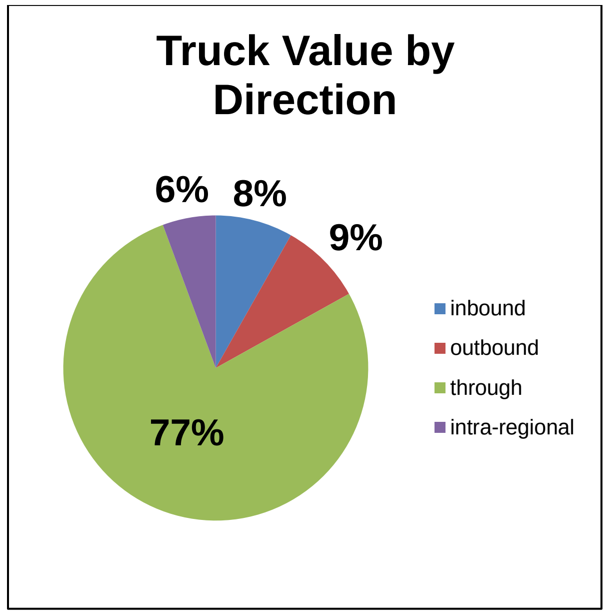
Figure 3.1 Tucson regional freight facilities



Most truck activity in the region is concentrated on the interstate system, primarily serving freight moving through Pima County, to and from larger markets in Phoenix, Southern California, Texas and beyond. Nearly 60 percent of trucks and 77 percent of over-the-road goods traveling the region's roadways are passing through Pima County (**Figure 3.2**). And while the efficient flow of goods on the interstate is essential for sustaining a strong national economy, regional economic impacts of pass-through freight — beyond the negative impacts stemming from increased congestion and vehicle emissions — are negligible. That said, being located on a critical national freight corridor can present opportunities in the areas of logistics and distribution.

Figure 3.2 Truck units and value by direction (2013)





Source: PAG analysis of 2013 TRANSEARCH

Truck trips beginning and ending in Pima County are important to the growth of the local economy; they use both the interstate system and locally operated roadways to get cargo to its final destination. From a regional perspective, both pieces of the road network are equally critical: interstates for long-distance shipments, and locally operated roadways for the "last-mile" connections. Disruptions or delays on any part of the journey slow deliveries and reduce the reliability of goods movement. Such issues can increase costs and affect bottom lines, make the region less attractive for business expansion and hamper economic competitiveness.

In total, the regional network has nearly 4,700 lane miles of larger roadways, almost 500 of which are classified as freeway or interstate (**Table 3.1**).

Table 3.1 Lane miles of major roadways in eastern Pima County

Roadway Facility Type	Lane Miles	Percent of Total System
Freeway	497	11%
Parkway	37	1%
Major arterial	1,528	33%
Minor arterial	2,140	46%
Collector	212	5%
Ramp	84	2%
Frontage road	172	4%
Total	**4,670**	**100%**

Source: PAG Travel Demand Model (2015)

The Interstate System

Interstates are limited-access, divided highways that use grade-separated intersections and on-and-off ramps to safely carry high volumes of high-speed traffic. The PAG region sits at the junction of two interstates, both of which are part of the national Interstate Highway System. Interstate 10 passes through the west and south sides of the City of Tucson and is more than 2,460 miles long, connecting Los Angeles to Jacksonville, Fla. I-19 intersects with I-10 just south of downtown Tucson and runs 64 miles south to Nogales, Arizona.

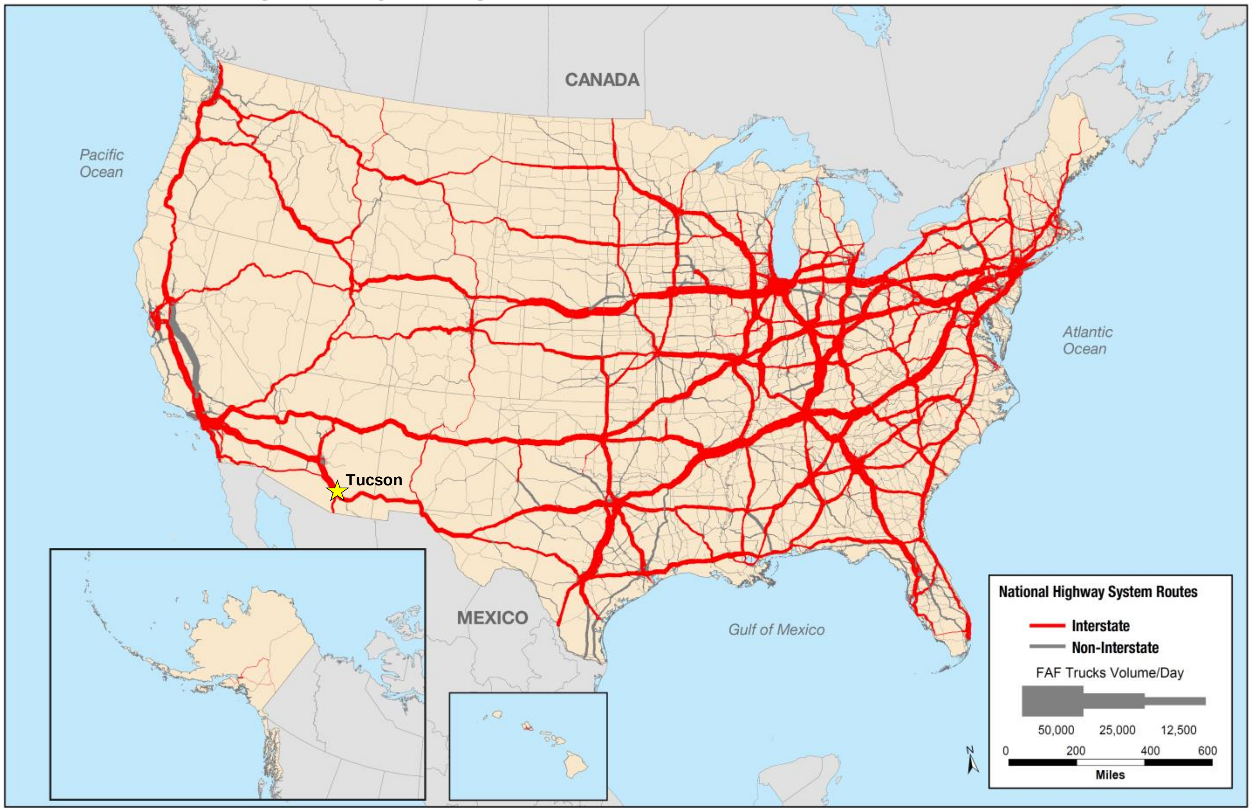
Within the Tucson metropolitan area, I-10 ranges from four to eight lanes and passes through a largely suburban or urban environment. Interstate 19, on the other hand, is primarily four lanes and operates in a more rural context, except north of the San Xavier District of the Tohono O'odham Nation, where it becomes more urban.

Both I-10 and I-19 are vital national corridors for freight and passenger vehicles. They form the southern connection of the CANAMEX Corridor, a Congressional High Priority Corridor on the National Highway System, and an important connection with Mexico. Interstate 10 is the commercial tether to the ports of Long Beach and Los Angeles, the largest container port facilities in the United States and the major entry point for goods originating in Asia. Over 37 percent of all containers imported into the United States enter the country through these two California ports.[43]

[43] Kitroeff, Natalie. "Competitors are eating into L.A. ports' dominance." *Los Angeles Times*. April 27, 2016. http://www.latimes.com/business/la-fi-la-ports-competition-20160427-story.html.

Over-the-road freight, traveling eastward out of the Los Angeles area, moves primarily along I-40 in northern Arizona and I-10 in the south, meaning that the PAG region is located on one of the nation's key corridors for imported Asian goods as well as those produced in Southern California (**Figure 3.3**).

Figure 3.3 Average Daily Long-Haul Traffic on the NHS 2011[44]

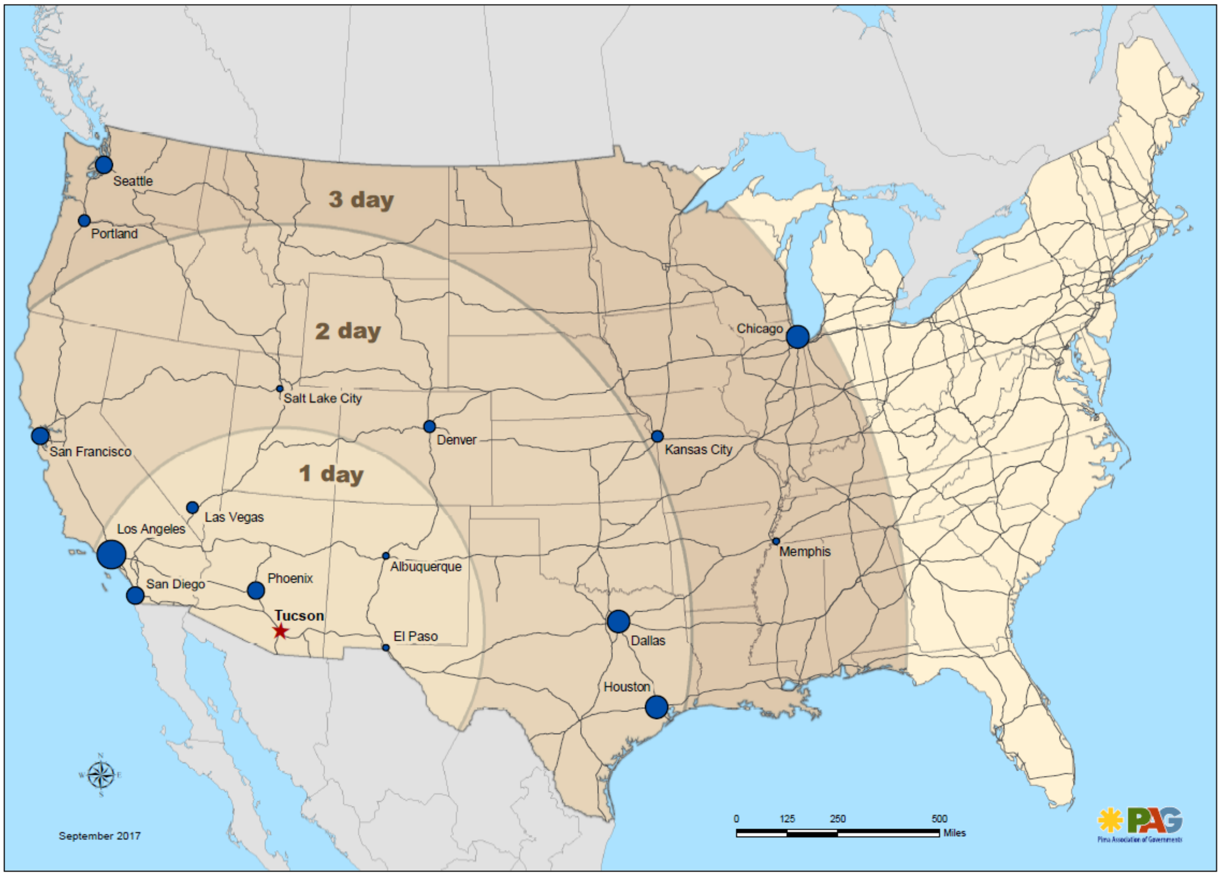


Source: FHWA Freight Analysis Framework version 3.4

Trucks originating in Pima County can reach most major Western markets in two days and can reach several other markets in three. **Figure 3.4** shows the major metropolitan areas that can be accessed by a truck from Tucson in one, two or three days. The region is one travel day from Los Angeles, Las Vegas and San Diego; two days from San Francisco, Dallas and Houston, and three days from Portland and Seattle.

[44] U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.4, 2013. https://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/images/hi_res_pdf/nhslnghultrktraf2011.pdf.

Figure 3.4 Estimated freight truck travel days from Tucson to major markets[45]



The importance of I-10 as the commercial tether to Los Angeles and its ports is demonstrated by the fact that trucks originating in Los Angeles account for more than 25 percent of truck miles driven on I-10 in Pima County. The next closest origin markets, in terms of generating truck vehicle miles traveled (VMT) on the regional portion of I-10, are Houston and Mexico, both at 6.2 percent (**Table 3.2**).

45 Note that Figure 3.4 was created by placing 500-mile travel bands around the PAG region, which is assumed to be the average distance a long-haul truck will cover in a single day. The map is based on straight-line distances and does not account for the effects of interstate routing, the impacts of interstate congestion on truck travel time, or operating characteristics of different freight carriers.

Each day, between 6,000 and 9,000 combo trucks travel on I-10 within the PAG region (**Table 3.3**).[46] On I-19, the number of daily trucks is closer to between 2,000 and 4,000 (**Table 3.4**). The highest combo truck volume locations are between downtown Tucson and the Pinal County line. On average, combo trucks represent anywhere from 5 percent to 13 percent of vehicles moving on the region's interstates.

Table 3.2 Annual truck VMT on I-10 by origin region (2013)

Origin Region	Annual VMT on I-10	Percent of Total
California Portion of Los Angeles BEA	29,784,845	22.03%
Houston, TX BEA	8,354,849	6.2%
Mexico Other	8,343,025	6.2%
San Francisco, CA BEA	6,986,684	5.2%
Maricopa County, AZ	6,831,606	5.1%
Los Angeles County, CA	6,492,232	4.8%
Texas Portion of Dallas, BEA	5,309,503	3.9%
San Antonio, TX BEA	3,284,876	2.4%
Texas Portion of El Paso BEA	3,083,192	2.3%
San Diego, CA BEA	2,843,271	2.1%

Source: PAG analysis of TRANSEARCH Data

Table 3.3 5-year combo trucks, I-10 highest average volume locations

Route	Start	End	2011	2012	2013	2014	2015	5-year Avg.
I-10	Speedway Boulevard	St. Mary's Road	5,198	5,408	5,993	12,607	6,453	7,132
I-10	St. Mary's Road	Congress Street	5,649	5,519	5,681	11,784	6,651	7,057
I-10	Marana Road	Tangerine Road	7,457	6,894	7,008	7,158	6,523	7,008
I-10	Grant Road	Speedway Boulevard	3,826	4,552	6,927	12,110	6,893	6,862
I-10	SR 77 / Miracle Mile	Grant Road	3,376	5,075	6,855	12,938	5,768	6,802
I-10	Avra Valley Road	Twin Peaks Road	6,011	6,184	6,103	7,700	5,896	6,379
I-10	El Camino Del Cerro Road	Prince Road	3,639	4,447	4,602	9,668	8,907	6,253
I-10	Congress Street	22nd Street/ Starr Pass Boulevard	5,798	5,175	4,265	10,158	5,864	6,252

Source: ADOT, Average Annual Daily Traffic Reports

[46] Note: Combo trucks are multi-unit or combination commercial vehicles. These are heavy-weight trucks, typically in a tractor-trailer combination, commonly used by freight motor carriers. The combo truck designation comes from ADOT's traffic count reports and includes FHWA classes 8 to 13. These counts exclude single-unit trucks.

Table 3.4 5-year combo trucks, I-19 highest average volume locations

Route	Start	End	2011	2012	2013	2014	2015	5-year Avg.
I-19	SR 86 West/ Ajo Way	I-10 (Exit 260)	3,133	2,297	2,550	8,661	2,799	3,888
I-19	Pima Mine Road	Papago Road	1,850	2,426	2,827	7,410	2,946	3,492
I-19	Papago Road	San Xavier Road	1,716	1,767	2,250	7,433	2,332	3,100
I-19	Sahuarita Road/Helmet Peak Road	Pima Mine Road	1,992	2,216	2,448	4,914	2,556	2,825
I-19	SB 19/Duval Mine Road	Sahuarita Rd/ Helmet Peak Road	2,009	2,305	2,522	3,987	2,686	2,702
I-19	Esperanza Boulevard	SB 19/Duval Mine Road	1,600	2,163	2,448	3,112	2,493	2,363
I-19	Continental Road	Esperanza Boulevard	1,570	1,940	2,246	2,611	2,140	2,101
I-19	Irvington Road	SR 86 West/ Ajo Way	2,024	2,009	2,090	2,091	2,151	2,073
I-19	Valencia Road	Irvington Road	1,829	1,774	2,182	1,663	2,215	1,933

Source: ADOT, Average Annual Daily Traffic Reports

Truck volumes are highly variable over the course of the year. Typically, national over-the-road shipments increase in the fall in preparation for the holiday season but tend to taper off in late December and into the first quarter of the calendar year. In southern Arizona, however, the pattern is quite different. The Mariposa Border Port of Entry (BPOE) in Nogales, Arizona, is a primary entry point to the United States for fresh produce during the winter season, most of it originating in Sonora and Sinaloa, Mexico (see text box on following page).

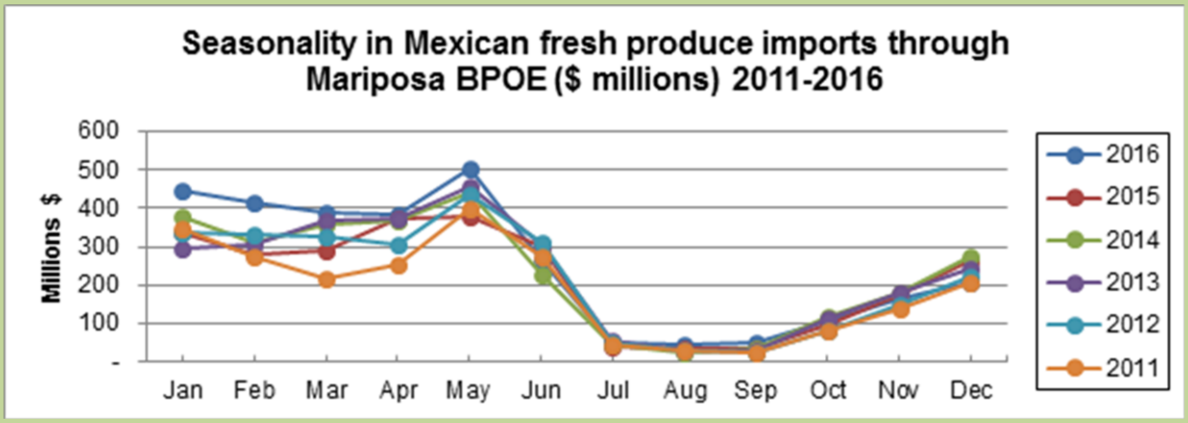
Interstate 10 and I-19 also serve a more regional function by supporting daily commuter travel between the region's cities and towns and by connecting regional employment centers. The region's more urban freeway segments, particularly I-10 between downtown Tucson and Ina Road, move between 110,000 and 180,000 total vehicles per day, while more suburban and rural sections move closer to 40,000 to 80,000 vehicles on average. Most of this volume is the result of intraregional trips.

PAG estimates that 52 percent of miles traveled on I-10 and I-19 come from vehicles traveling wholly within the region, while 10 percent result from vehicles passing through the region, to and from locations outside of Pima County (**Table 3.5**). So, while most commercial trucks are using the interstates to move through the region, passenger vehicles are primarily using the interstates as key intraregional corridors.

FREIGHT SEASONALITY – MEXICAN FRESH PRODUCE

Imports of fresh vegetables, fruits and nuts from Mexico are a major source of freight in southern Arizona. The Mariposa Border Point of Entry — located in Nogales, Arizona, approximately one hour south of Tucson along I-19 — is one of the primary entry points for Mexican fresh produce entering the United States. The Nogales facility is the largest BPOE in Arizona and facilitates more than 90 percent of the Mexican fresh produce entering the state. The remaining 7 percent or 8 percent enters through the San Luis BPOE, and another 1 percent to 2 percent through the Douglas BPOE.

From 2005–2015, U.S. imports of fresh produce from Mexico via Arizona BPOEs increased 50.9 percent. According to U.S. Census data, in 2016, the value of fresh produce imported from Mexico through the Mariposa BPOE was valued at over $3 billion. The vegetable and melon sector was the largest produce sector for international trade, followed by the fruits and tree nuts sector. With this marked increase in Mexican produce production and importation, especially from northern Sinaloa and Sonora, the Nogales peak season extends from December until the end of June. During this time, the volume of cross-border truck movements and produce increases dramatically as shown in the figure below. At the same time, border-crossing wait times and congestion along I-19 also increase.



Growth in Texas crossings

Over the past decade, growing agricultural production in central Mexico, higher demand for Mexican produce, and improvements in both U.S. and Mexican infrastructure and highways have slowly eroded Arizona's position as the primary point of entry for Mexican fresh produce into the United States. According to the U.S. Census Bureau, Nogales lost its position as the major entry point for fresh produce–based on dollar value–from Mexico. In 2015, Hidalgo, Texas, surpassed Nogales, which dropped to second place. The largest infrastructure improvement has been the 143-mile Autopista Durango-Mazatlán, which opened in 2013 and drastically cut travel time between the growing regions of west Mexico to Texas. These factors have led to importers and distributors taking advantage of cost savings for delivery to Midwest and East Coast *markets by traveling through Texas. Consequently, many Nogales-area distributors and new companies are building facilities in Texas.*

Pavlakovich-Kochi, V., Nadelhoffer, M., Hoogasian, A., & Sheldon, L. (2016, May 15). *Arizona-Mexico Economic Indicators, Arizona's Trade and Competitiveness in the U.S. – Mexico Region*. Retrieved from https://azmex.eller.arizona.edu.
[2] U.S. Census Bureau: Economic Indicators Division USA Trade Online. *U.S. Import and Export Merchandise trade statistics*. Retrieved from http://usatrade.census.gov.
[3] Fresh Produce Association of the Americas. (2015-16). *2015-16 Nogales Produce Import Report*. Retrieved from http://www.freshfrommexico.com/.
[4] Pavlakovich-Kochi, V. (2016, March 9). *Nogales, AZ: Still main gateway for fresh produce from Mexico?* Retrieved from https://azmex.eller.arizona.edu.

Table 3.5 Interstate VMT in the PAG region by trip type (2015)

Interstate trip type	VMT	Percent of total
External to external (pass through travel)	545,658	10%
Internal to internal (intraregional travel)	2,946,141	52%
External to internal (into Pima County)	1,097,655	19%
Internal to external (out of Pima County)	1,108,639	19%

Source: PAG Travel Demand Model

Regional Interstate Performance

The dual function of the region's interstates means that facility performance affects regional as well as national movement of goods and people. Congestion and disruptions on the region's interstates—whether caused by regional commuter travel, locally generated commercial activity, national truck traffic or intermittent events, such as traffic incidents, inclement weather or construction—can inconvenience passenger and commercial vehicles alike.

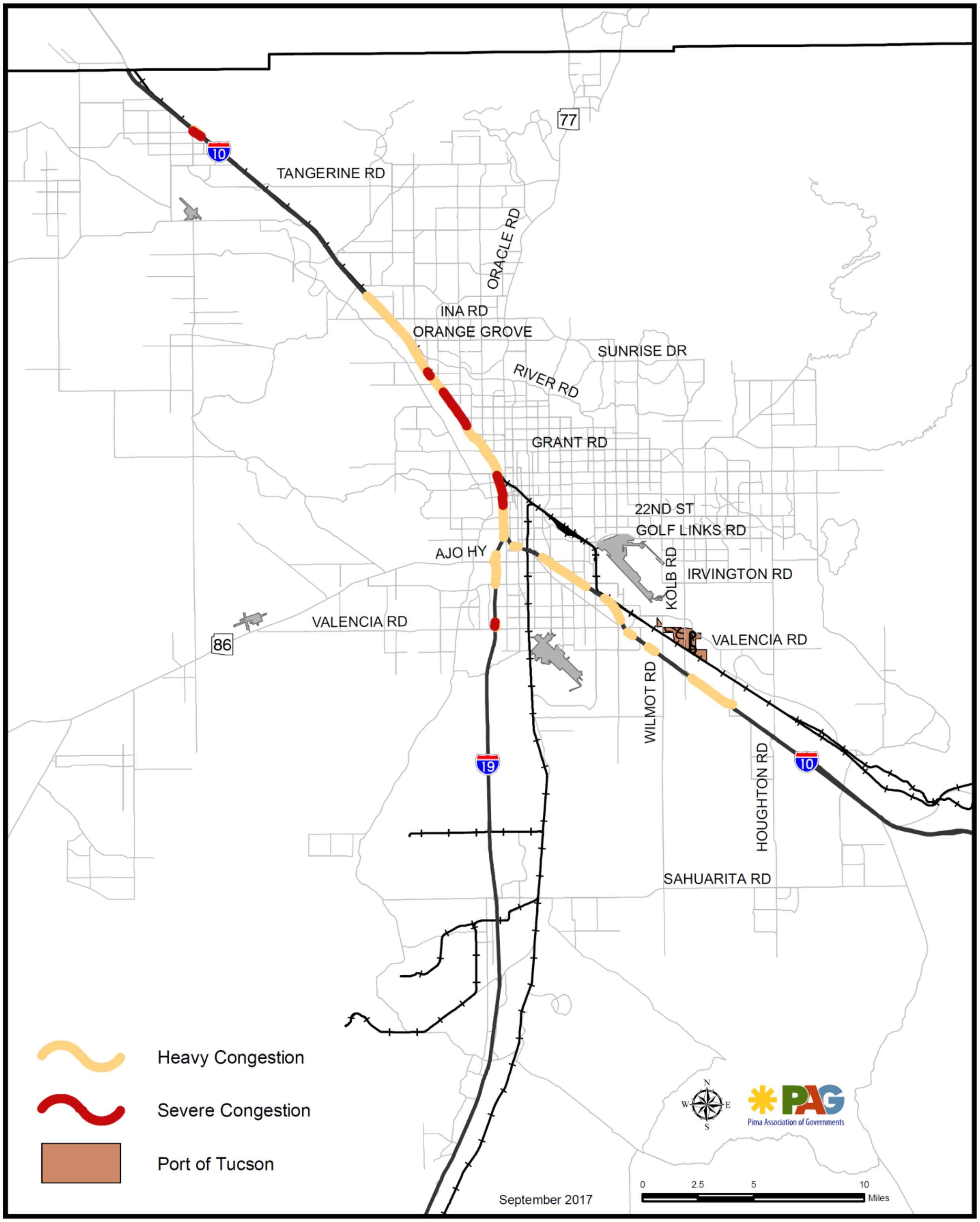
Fortunately, at least from a capacity perspective, the PAG region's freeways are performing relatively well. Under normal operating conditions, trucks and other traffic move freely most of the day. Some peak-hour bottlenecks do exist, such as on I-19 near Valencia Road, through downtown Tucson, and north of Grant Road; that said, the region's freeways are less congested overall than those in many metropolitan areas. (**Figure 3.5**).

Though interstates are performing well in terms of congestion, the system has other challenges. According to ADOT's recently conducted Corridor Profile Studies for I-10 East (south Phoenix to the New Mexico state line) and I-19, portions of the local interstate system perform below average regarding safety and reliability when compared with similar facility types in Arizona.

Along I-19, large sections between I-10 and the Santa Cruz County line have below-average safety performance and include several identified "safety hot spots," where particularly high concentrations of fatal or incapacitating crashes occur (**Figure 3.6**).[47] The corridor also has a number of low-rated bridges, which may need rehabilitation or replacement in future years. Even so, the I-19 corridor effectively serves current freight truck needs as reflected in the Corridor Profile Study's Freight Index measure (**Figure 3.7**).[48]

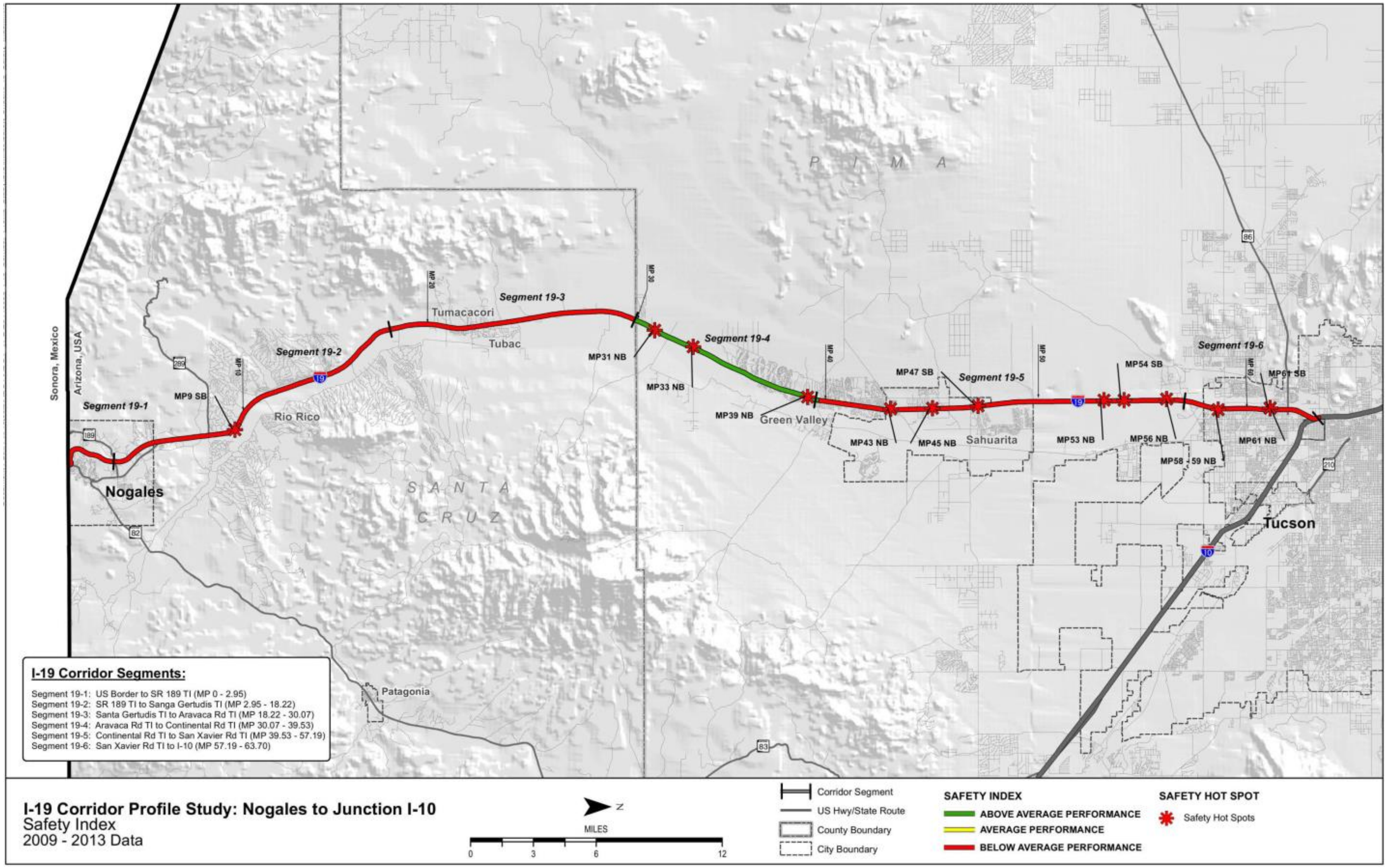
[47] Safety performance is inclusive of all vehicle types, not specific to freight vehicles. Freight vehicle crash performance is covered in more detail in a later section of this chapter.
[48] The Freight Index is a reliability measure based on travel time needs for 95 percent on-time arrival.

Figure 3.5 Current peak-hour interstate congestion (2015)



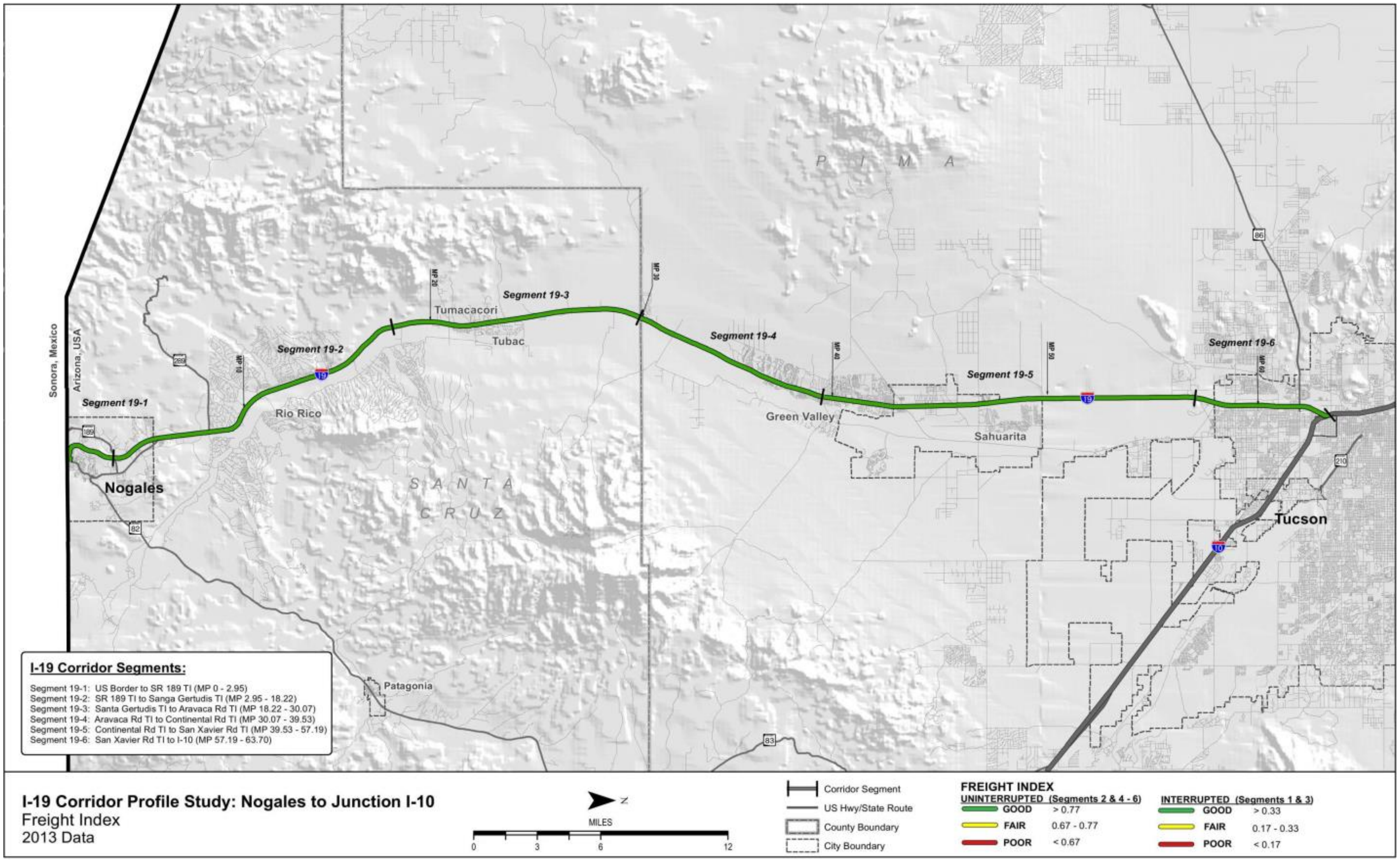
Source: PAG travel demand model

Figure 3.6 I-19 Safety performance (2009-2013)



Source: ADOT I-19 Corridor Profile Study: Nogales Junction to I-10 – Final Report

Figure 3.7 Freight truck performance on I-19 (2013)



Source: ADOT I-19 Corridor Profile Study: Nogales Junction to I-10 – Final Report

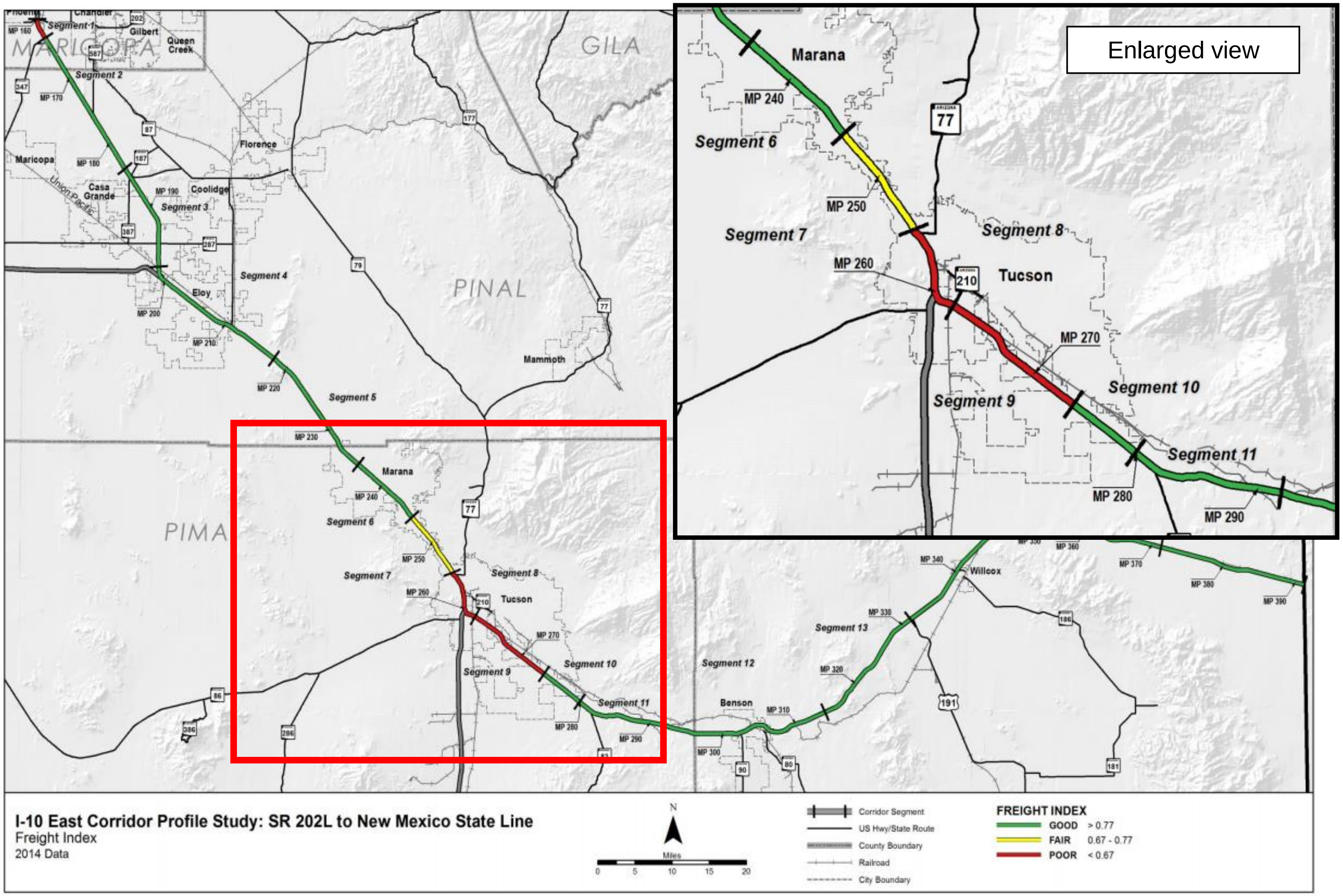
THE IMPORTANCE OF RELIABILITY IN FREIGHT

Reliability, referred to throughout the Freight Plan, is one of the most important considerations of how well the transportation system is serving freight. Reliability is a way of assessing the predictability of travel times on a given transportation network. For example, if travel to work always takes 30 minutes at midday and 50 minutes at peak hour, this is a highly reliable network. Even though there are an extra 20 minutes of congestion each day at peak hour, this can be predicted and arrival times planned accordingly. However, if the peak-hour trip takes 50 minutes most days but more than 70 minutes a few days each month due to non-recurring delay, then arrival times become unpredictable and planning becomes difficult. This is an unreliable network. Given this situation, the commuter will arrive late for work a few days a month, leading to lost time and inefficiencies.

For freight shippers, reliability is critical for managing shipping costs and ensuring products get to market on time. Long travel distances, daily truck driving limits, labor costs and highly complex supply chains make reliability a far more significant challenge with much higher stakes. If the transportation system is unreliable, freight-intensive businesses are affected in several ways: freight assets become less productive, requiring businesses to put more trucks on the road to meet their customers' needs; costs associated with warehousing goods and carrying large inventories increase in order to ensure adequate supplies for production or assembly; delivery windows are missed, disrupting supply chains; and labor is employed at less-than-optimal efficiency.

Interstate 10 through the PAG region also has some challenges. The corridor, though not experiencing significant recurring delay, is beginning to approach its available capacity on multiple segments, thereby leading to slower traffic flow at peak hours. The Tucson section of the corridor has four “safety hot spots,” and non-recurring delay is more pronounced than on many similar corridors in the state. Of greatest relevance to the Freight Plan, freight truck reliability performance is poor compared with other urban freeways in Arizona, resulting in unpredictable deliveries and lost time for commercial vehicles traveling through region (**Figure 3.8**).

Figure 3.8 Freight truck performance on I-10 (2014)



Source: ADOT I-10 Corridor Profile Study

A primary challenge facing the region's interstate system is that, with projected population and goods-movement growth, many segments of Tucson's freeway system are anticipated to become severely congested in the near to mid-term. As both freight and commuter travel increase, long-distance freight movement will become a more significant contributor to local congestion, and local congestion will increasingly impede freight performance to the detriment of local and distant economic activity.

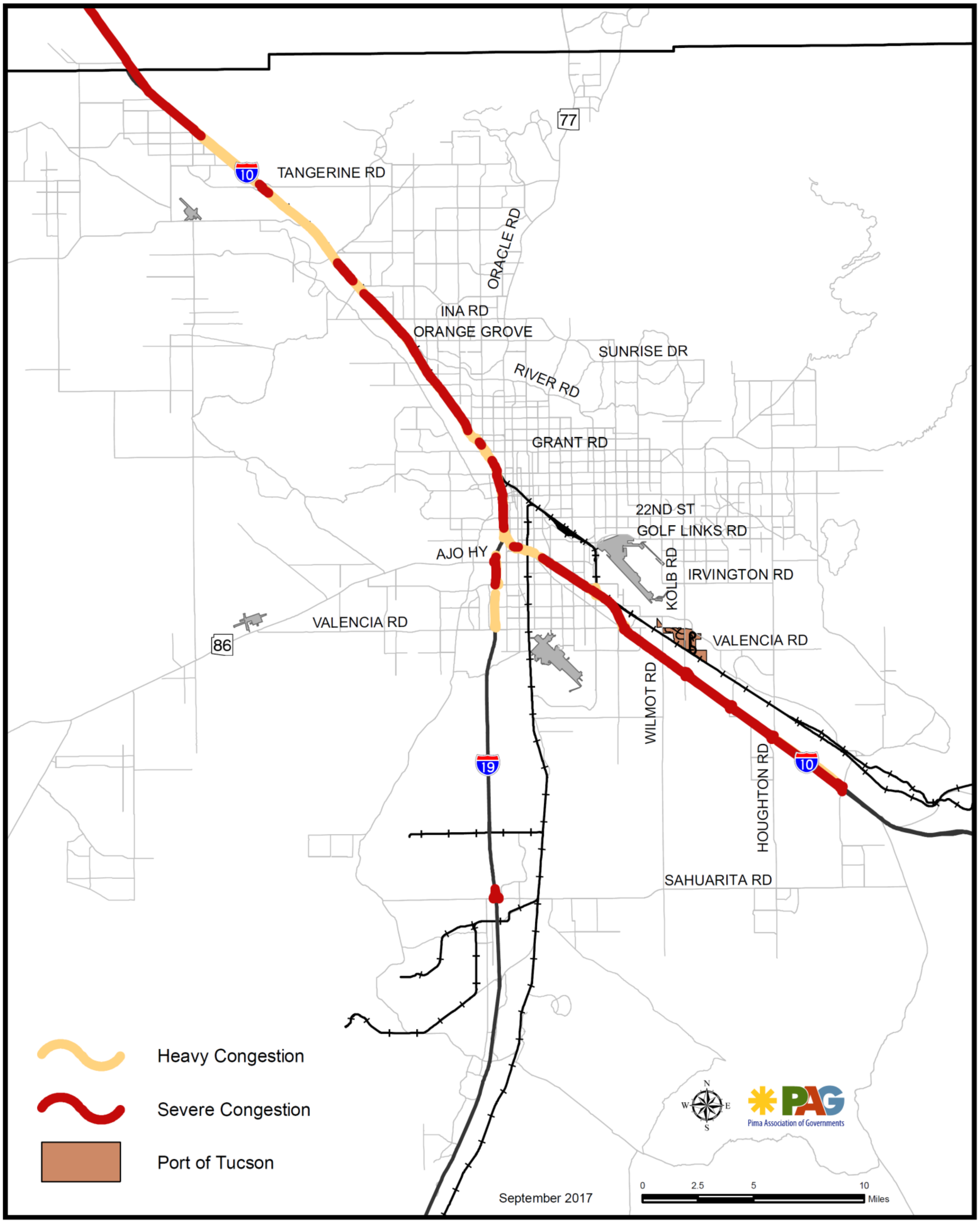
If interstate capacity does not keep pace with expected future traffic demand, the traveling public and freight trucks will experience considerably more daily delay at both peak and non-peak hours. Additionally, many of the current issues on the interstates, such as crashes and freight reliability, will become more pronounced as traffic volumes exceed ideal operating conditions, reducing any advantages the region currently enjoys with regard to freight access. It is important to ensure that the region is prepared to accommodate this growth through appropriate capacity expansions and operational enhancements. Laying the groundwork for emerging technologies — particularly connected and autonomous vehicles — will allow for more efficient use of limited roadway capacity. **Figure 3.9** shows future projected interstate congestion if no additional capacity is added.

Several projects currently planned and/or programmed on the region's interstates will begin to address some current and future challenges, including on I-10, east of the I-19 interchange. The project list can be found in **Chapter 5** of this Freight Plan. Again, planned regional projects do not necessarily have guaranteed funding for construction. The region will need to continue to work with state and federal funding partners to ensure that future resources are available to meet identified needs.

Two regional state route projects under study also will have a considerable effect on interstate performance and freight movement: the extension of SR 210 and the construction of SR 410, commonly called the Sonoran Corridor. The SR 210 project will extend Barraza-Aviation Parkway south from its current endpoint at Golf Links to a tie-in with I-10. The project will include construction or reconfiguration of interchanges at Barraza-Aviation and Golf Links and at I-10. The SR 210 project is being studied as part of ADOT's *Interstate 10 and State Route 210 Phase II Feasibility Study*, which will result in a Design Concept Report and Environmental Assessment (EA) for the corridor.[49]

[49] More information on the feasibility study can be found at www.azdot.gov/i10SR210study.

Figure 3.9 Projected interstate congestion – without projects (2045)



Source: PAG 2015 travel demand model

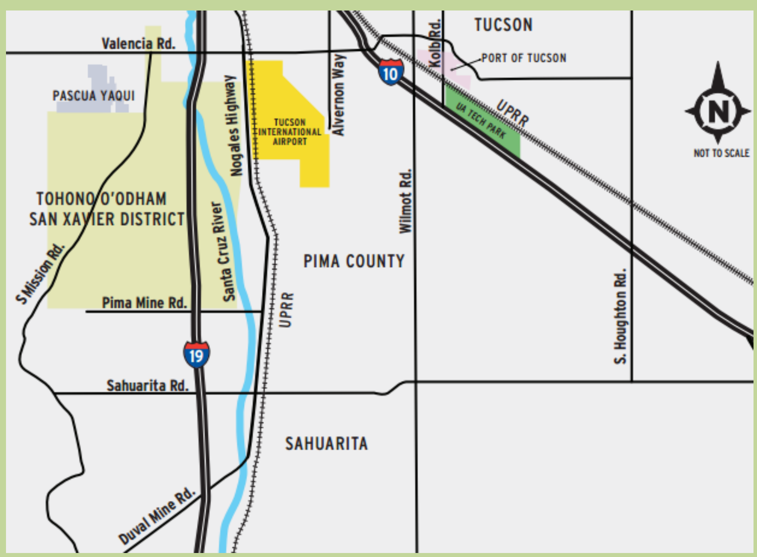
The SR 410: Sonoran Corridor project is a proposed new high-capacity transportation facility connecting I-19 to I-10 in the area south of Tucson Inte rnational Airport (see sidebar). The SR 410 corridor is currently undergoing a Tier 1 Economic Impact Statement (EIS), which will result in a preferred corridor alternative as required by the National Environmental Policy Act (NEPA).[50] Both studies are expected to conclude in 2019.

IN FOCUS: SR 410 – THE SONORAN CORRIDOR

In June 2015, Arizona's Congressional delegation made a successful bid to have the Sonoran Corridor designated as a Congressional High Priority Corridor and Future Interstate and included it in the 2015 FAST Act. While this designation did not provide funding, it brings national recognition, making projects on the corridor more competitive for future funding opportunities. The purpose of the corridor is to:

- ***support expansion of the region's aerospace, defense and advanced manufacturing sectors***
- ***enhance freight and logistics opportunities by connecting air, rail, interstate and intermodal facilities***
- ***facilitate international goods movement between Mexico and points east***
- ***attract major new employers***

Though the specifics of future investments are yet to be defined, an early study commissioned by Pima County estimates that the Sonoran Corridor could have an annual regional economic impact of $32 billion, while creating 200,000 jobs.[1] The Tier 1 EIS will result in a 2,000 foot-wide preferred corridor alternative, a major step in making this high-priority infrastructure investment a reality.



Source: ADOT

[1] http://webcms.pima.gov/cms/One.aspx?pageId=227319

[50] The SR 410 project page is available at www.azdot.gov/sonorancorridor.

The Arterial Roadway Network

In terms of over-the-road goods movement, the region's interstates are transportation assets of national significance and the region's most important freight corridors. However, unique to the PAG region is the relative importance of the arterial network for regional mobility. Unlike many similar-sized and larger metropolitan regions, the PAG region has no freeway or "loop" road serving cross-town traffic flows. This creates challenges in balancing the needs of freight with those of the broader traveling public. Some of these challenges can be mitigated by identifying major freight corridors and continuing to ensure that major freight-generating businesses are able to locate in areas where their freight vehicles can enter and exit the region without having to travel on heavily used urban corridors.

Interstate 19 and I-10 connect Pima County to outside markets and are, therefore, critical to the region's growth and economic future, but it is the regional arterial network that serves most daily travel and provides first- and last-mile access to the region's producers and consumers. One of the Tucson metro area's defining characteristics is the relatively limited number of freeway facilities and the greater importance of the arterial network. According to the Texas Transportation Institute's (TTI) *Annual Mobility Report*, the PAG region ranked No. 30 out of 33 medium-sized metropolitan areas in terms of freeway lane miles per capita, and ranked No. 2 out of 101 metropolitan areas in terms of share of vehicle travel on the arterial network.[51] In most regions, there is roughly a 50/50 split in freeway versus arterial travel; by contrast, in the PAG region, 75 percent of travel occurs on arterial roads.

In terms of mileage, the arterial network is the largest component of the region's transportation infrastructure system at over 3,600 lane miles of combined major and minor arterial roadways. Each arterial typically moves between 25,000 and 50,000 vehicles per day, with the whole system carrying an average of more than 11 million total daily vehicle miles.[52] **Table 3.6** shows examples of traffic volumes on selected arterial roadways, using the most recently conducted traffic counts. The table includes a selection of volumes on arterial roadways, not the highest volume locations.

[51] Note: The TTI *Annual Mobility Report* provides data on arterial and freeway facilities but excludes information on collector, local streets and ramps. If PAG's entire network is considered, about 67 percent of travel occurs on arterials and collectors, 20 percent on freeways, and the remainder on local streets. The TTI report is used because it allows for comparisons between metropolitan regions.

[52] Arizona Department of Transportation, Highway Performance Monitoring System, Individual Urbanized Tables.

Table 3.6 Traffic counts at select arterial locations (2014–2016)

Location	Start	End	Daily Traffic Volume (all vehicle types)
Ina Road	N Shannon Road	Mona Lisa Road	29,842
Grant Road	Swan Road	Craycroft Road	39,571
Oracle Road	Ina Road	Magee Road	53,896
Valencia Road	S. Mission Road	Midvale Park Road	43,075
Kolb Road	Valencia Road	Irvington Road	48,061
Broadway Boulevard	Country Club Road	Alvernon Road	39,007
Alvernon Way	Irvington Road	Ajo Way	36,494
Cortaro Road	Silverbell Road	I-10	26,526

Source: PAG Traffic Count Program

Table 3.7 shows which locations have the highest volume of multi-unit trucks, according to PAG's 2014–2016 traffic counts (single-unit counts also have been included in the table, though these are not necessarily the highest volume locations). It is important to note that truck counts are not conducted on the entire arterial road network. Of the approximate 1,200 locations in the region in which PAG conducts traffic counts, only 194 locations were counted for trucks from 2014 to 2016, so other locations may have higher volumes of multi-unit trucks than those listed in the table. PAG will work to expand coverage of truck count locations in the years to come. Because of the current lack of coverage, PAG has acquired additional datasets to assist in the development of the Freight Plan, which is discussed in more detail in the next section.

Single-unit and combo trucks use the entire non-interstate road network to move freight, with the highest truck volumes on roadways serving large retail clusters, manufacturing centers, extractive industries, and transportation and logistics hubs. Of the locations counted, multi-unit trucks account for roughly 0.5 percent to 1.5 percent of total traffic volume on arterial roadways. The share of single-unit trucks is slightly higher on some of these roadways and may be in the range of 2 percent to 3 percent. This is much lower than the share of multi-unit trucks on I-10, which is in the range of 8 percent to 13 percent through the PAG region.[53]

[53] ADOT, Average Annual Daily Traffic Counts https://www.azdot.gov/planning/DataandAnalysis.

Table 3.7 Highest volume multi-unit truck count locations (2014–2016)

Location	Start	End	Single unit trucks	Combination trucks (multi-unit)
Alvernon Way	Ajo Way	Golf Links Road	1,221	794
Golf Links Road	Wilmot Road	Kolb Road	1,525	345
Alvernon Way	River Road	Ft. Lowell Road	337	255
Grant Road	Silverbell Road	I-10	648	233
Broadway Boulevard	Kolb Road	Pantano Road	544	216
Country Club Road	Fairland Strave.	Ajo Way	106	213
Benson Highway	Park Avenue	Ajo Way	366	187
Kolb Road	Speedway Boulevard	Broadway Boulevard	173	155

Source: PAG Traffic Count Program

Even though the share of multi-unit trucks on non-interstate roadways is relatively small, the trucks that are moving on the roads are essential to supporting the region's goods-based enterprises. Moreover, in addition to providing regional mobility to the driving public, many of the region's arterial and collector streets are also commercial corridors that attract local vehicle trips, bikes, pedestrians and public transportation while also serving freight vehicles and commercial deliveries. The confluence of competing uses can cause conflicts among the different user groups and lead to safety and mobility challenges for all travelers; this is most evident at signalized intersections, where crashes and congestion concentrate. As PAG's 2014 *Regionally Significant Corridors Study* states, "Along any roadway corridor, intersections are where bottlenecks occur, and therefore provide the capacity limitations for the roadway."

Over 700 signalized intersections in the PAG region must be managed and maintained to minimize the mobility and safety conflicts inherent in the transportation system. Crashes are more frequent at intersections where two or more roads cross each other and where activities such as turning left, crossing over, turning right and pedestrian crossing increase the potential for conflicts. According to PAG's 2016 *Strategic Transportation Safety Plan* (STSP), 41 percent of serious crashes occur at intersections, making them the most common locations for roadway injuries and deaths.

Freight Truck Volumes

At this time, no comprehensive regional truck count data exists for the non-interstate road network in Pima County, which could be used to indicate exactly which roadways are moving high amounts of freight. Therefore, as part of this planning process, PAG acquired a freight-truck specific dataset to support estimating and modeling truck volumes and operating performance on the region's roadways. The data source was obtained from the American Transportation Research Institute (ATRI).

ATRI provides GPS data collected from a sample of commercial trucks moving within Pima County. Sample GPS data can be used to identify significant truck origin and destination locations, routing and travel speeds. The ATRI data, combined with TRANSEARCH and PAG's limited truck count program, allow PAG to triangulate and crosscheck the data to get a better understanding of freight movement and freight generation in the region.

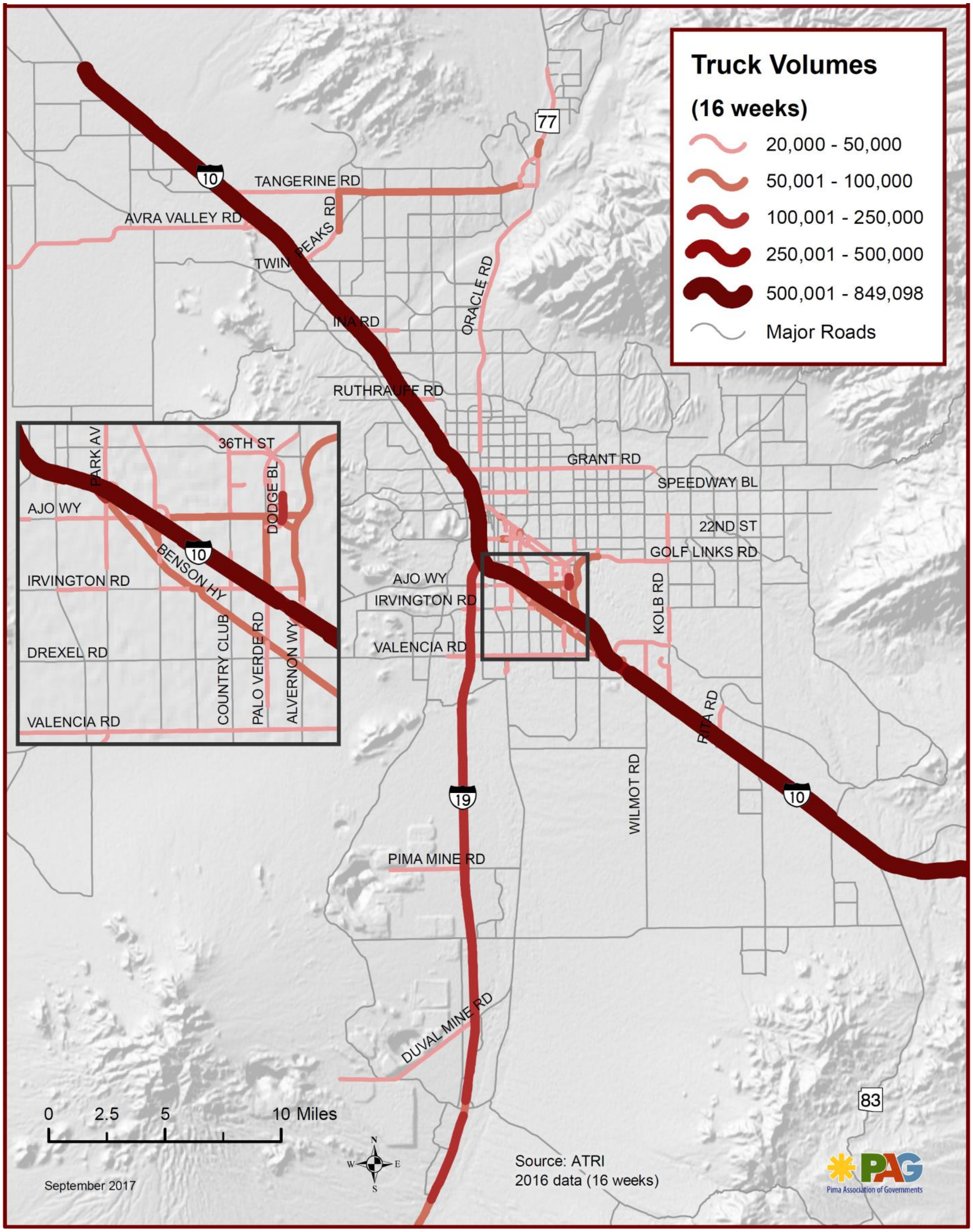
Sixteen weeks of GPS data—spanning the entire year of 2016 to account for seasonal variation—were acquired for trucks traveling within Pima County, with a GPS data resolution that varies from 1-minute frequency to 30-minute frequency. Each GPS record is tied to a unique truck ID number and spatially joined to a roadway network. Where GPS data resolution is low, routing is estimated using a truck traffic routing algorithm through PAG's travel model. The ATRI sample is largely limited to tractor-trailer, multi-unit freight trucks, though some single-unit delivery vehicles also may get captured in the data.

ATRI data were reviewed by PAG and checked against locations where PAG and ADOT have conducted truck counts. Using the counts, PAG was able to both validate the ATRI data and develop a sample ratio. In the locations where classification counts occurred, ATRI data provided truck samples of between 16 percent and 17 percent of total truck traffic. A sample correction factor was developed based on this sampling ratio, which was applied to the entire network.

The results were used to estimate the highest relative volume freight corridors in the PAG region based on 16 weeks of data samples collected (**Figures 3.10 and 3.11**). Importantly, the following maps do not provide average annual daily truck traffic (AADTT); instead, they show the estimated total truck traffic occurring over the entire16-weeks based on the sample with the expansion factor applied.

Figure 3.10 shows estimated truck volumes on the regional network over the 16 weeks for which data are available. The highest truck volumes, unsurprisingly, are seen on the interstates, particularly on I-10.

Figure 3.10 16-week truck volumes in eastern Pima County (2016)



Source: PAG analysis of ATRI GPS data

Figure 3.11 presents that same data but with the interstates removed to draw attention to higher volume non-interstate corridors. The highest-volume freight corridors are clustered west of DMAFB near South Alvernon Road (shown in the map inset). Other significant high-volume freight corridors include Oracle Road, Tangerine Road, Twin Peaks Road, Grant Road, Kolb Road, Pima Mine Road, Duval Mine Road and Avra Valley Road in addition to many shorter segments that connect industrial areas to the interstates.

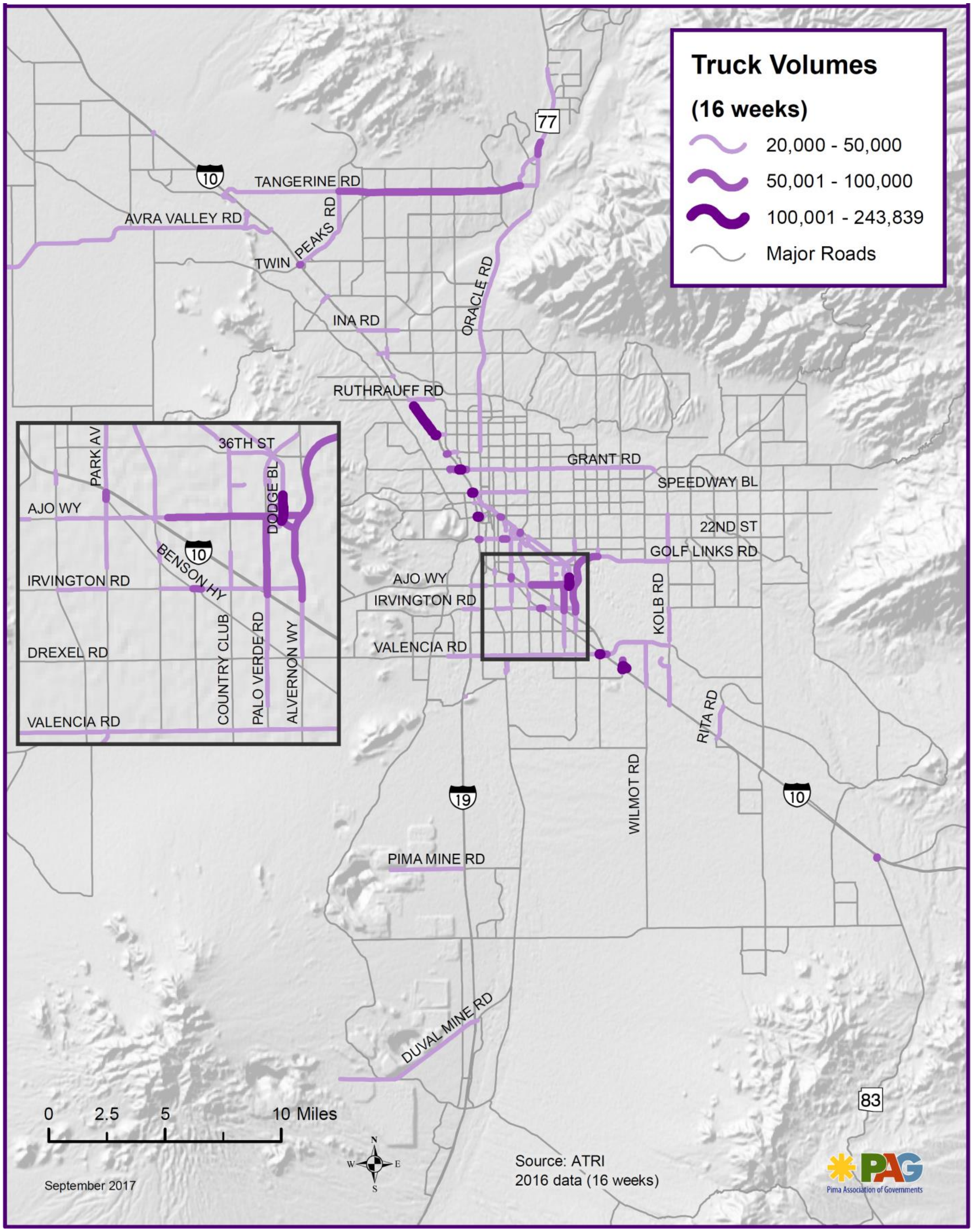
ATRI provides data only on truck movement but not on the contents of the trucks. To get a fuller understanding of which of the high-volume corridors is also serving high-value freight movement, PAG compared ATRI data with TRANSEARCH commodity flow data.

In addition to roadway routing, ATRI can be used to derive truck origins and destinations. This analysis can help to confirm locations that are generating or receiving freight or are otherwise attracting truck activity. Freight truck origin and destination locations, or what are called truck trip ends, were identified over the 16-week period by extracting GPS records from the ATRI data where trucks were recorded in the same location for more than 10 minutes. This was assumed to indicate stops, pick-ups or deliveries.

Figure 3.12 shows the locations where trucks stopped for at least 10 minutes in 2016, as indicated by a blue dot (each dot represents one truck stop of at least 10 minutes). The orange color bands show areas where there is a particularly high concentration of truck trip ends, with the darker color demonstrating a higher density of trip ends.

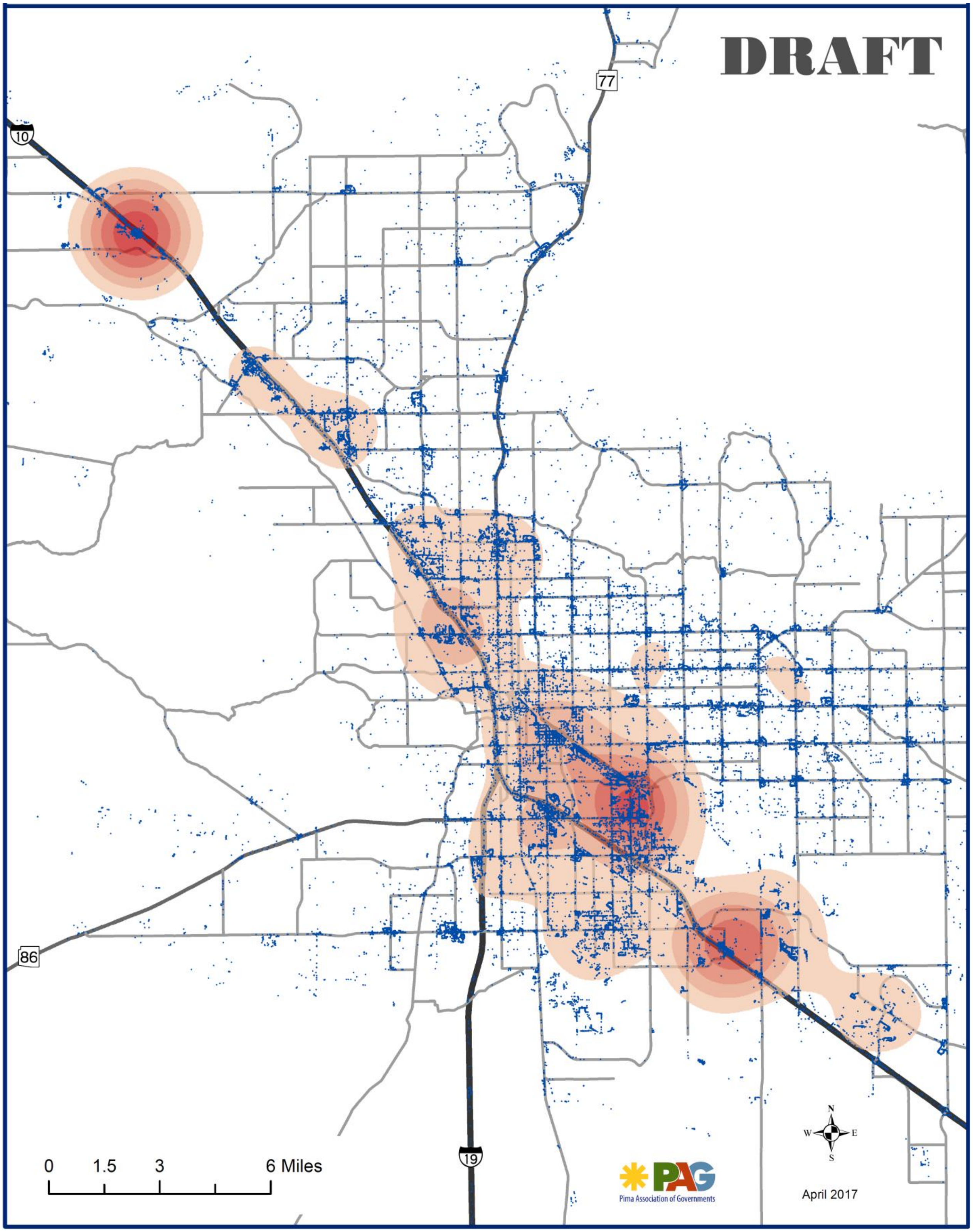
This analysis complements the Chapter 2 maps showing freight-intensive employment and TRANSEARCH TAZ-level freight tonnage and value to provide a strong indication of the region's primary freight activity areas. Major retail hubs, truck service centers and truck stops feature prominently in the truck trip ends map, but these locations would likely not be reflected in the earlier maps since those locations are not likely generating much freight.

Figure 3.11 16-week truck volumes in eastern Pima County, without interstates (2016)



Source: PAG analysis of ATRI GPS data

Figure 3.12 Truck trip ends in the Tucson urban area (2016)

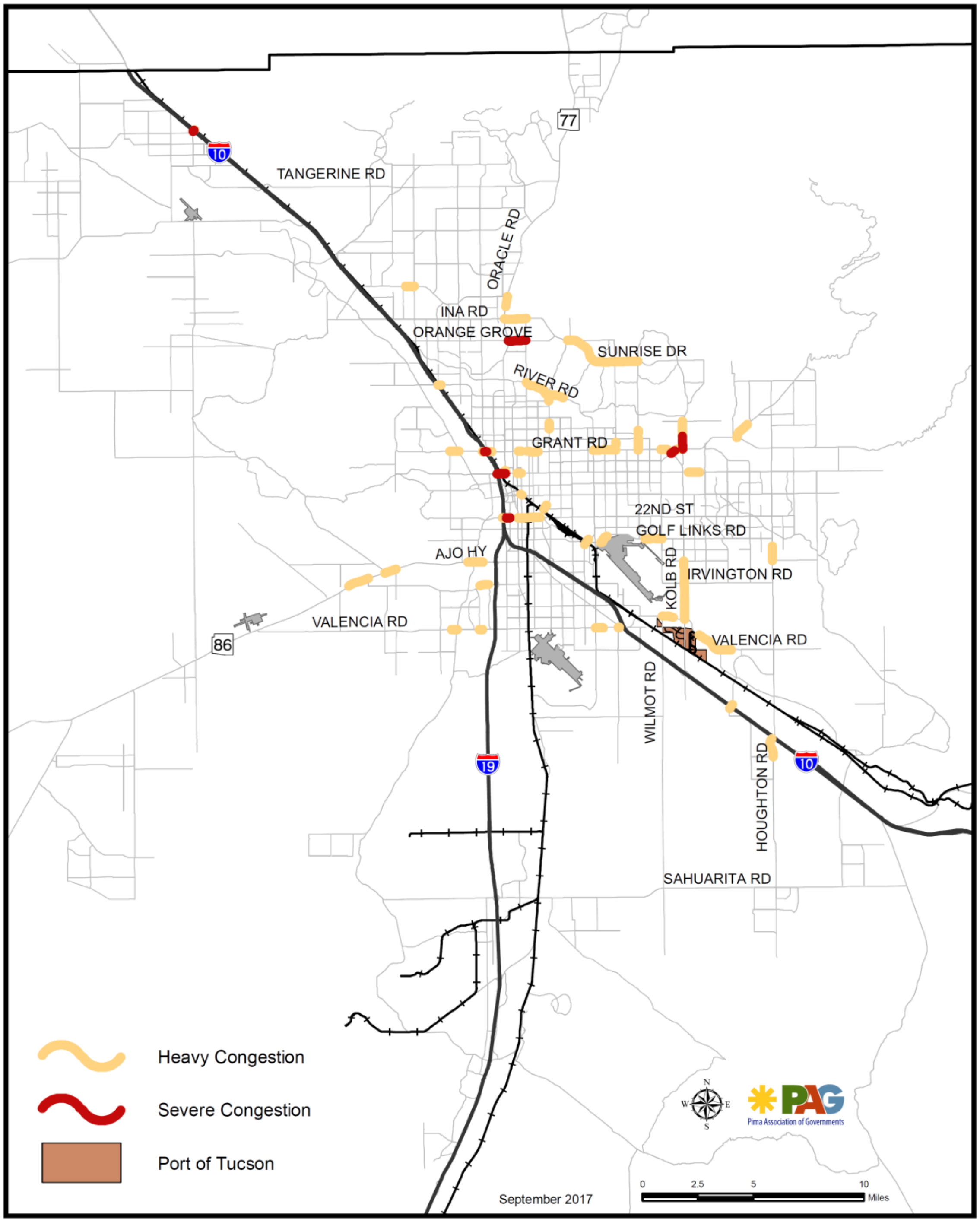


Source: PAG analysis of ATRI truck GPS data

Truck Congestion and Reliability

Non-interstate roadways in Pima County currently experience moderate peak-hour recurring congestion as seen in **Figure 3.13**. The worst congestion tends to occur at major intersections.

Figure 3.13 Peak-hour non-interstate congestion (2015)



Source: PAG travel demand model

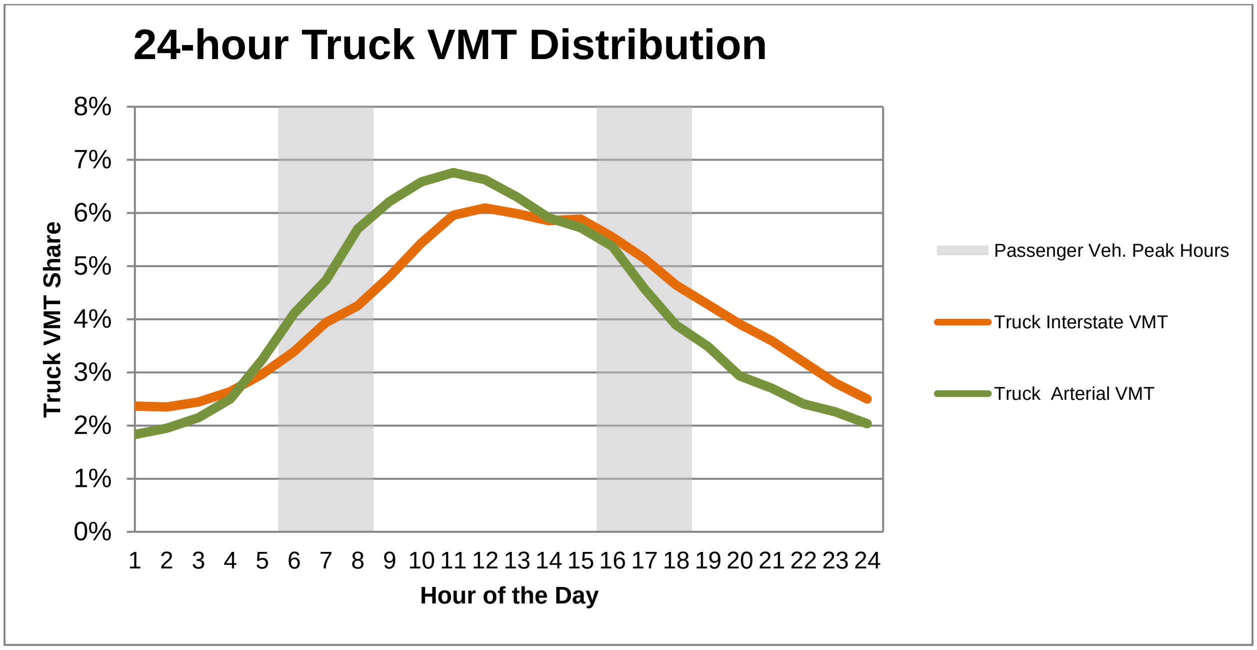
Because freight trucks operate under a different set of constraints from and for different purposes than the traveling public, recurring peak-hour congestion may or may not significantly affect freight movement and reliability. For example, shipments leaving production or distribution facilities before 7 a.m. will not be affected by the normal weekday congestion during the morning peak period. Since ATRI GPS data provides observed truck travel speeds on the roadway network, the information can be used to better understand the real operating conditions of freight vehicles. This includes information about which times are most common for the movement of goods, where delay is occurring on the network, the intensity of the delay and where reliability issues exist.

Peak freight-hour patterns vary from those of passenger vehicles. According to PAG's analysis of ATRI data, freight truck travel on the region's roadways begins to pick up around 7 a.m. and peaks at midday, before tapering off in the late afternoon. Passenger vehicle travel, on the other hand, peaks in the morning between 6 a.m. and 9 a.m. and again in the evening between 4 p.m. and 7 p.m. (**Figure 3.14**).

Nearly 45 percent of truck VMT on arterial roadways occurs between 9 a.m. and 4 p.m., while 28 percent of truck travel occurs during passenger peak periods (a similar, if less pronounced, pattern is observed on the interstate system). The offset in peak travel periods helps to reduce, though not eliminate, the effect of congestion on freight performance. Trucks traveling outside the peak period mostly experience relatively free-flowing road conditions. More challenging, from a freight-performance perspective, is truck travel occurring during the peak period, which is both affected by and a cause of traffic congestion.

An analysis of peak-hour freight performance can be done through the use of ATRI data to establish a network-level baseline for freight performance on arterials and interstates. The baseline used two freight measures to evaluate performance: travel time index (TTI) and planning time index (PTI). TTI is a measure of recurring peak-hour delay (peak being 6–9 a.m. and 4–7 p.m.) that estimates how much longer a trip, under normal operating conditions, is expected to take during the peak period than during free flow periods. A TTI of 1.5 means that a trip that takes 20 minutes in light traffic can be expected to take 30 minutes during peak period most days. PTI is a measure of reliability that accounts for unusually bad traffic conditions by comparing the 95th percentile travel time to free-flow conditions. In other words, PTI provides a measure of how much time should be allowed for a shipment (or traveler) to arrive on time 95 percent of the time, accounting for less predictable events, such as traffic accidents, inclement weather, special events and road work. A PTI of 2.0 means that a delivery should allow 1 hour for a trip that takes 30 minutes under free-flow conditions to ensure on-time delivery 95 percent of the time.

Figure 3.14 Share of truck VMT by hour of the day



Source: PAG analysis of ATRI truck GPS data

Table 3.8 shows freight truck TTI and PTI for the overall regional road network, as well as separately for interstates and non-interstate roadways. The numbers in the table are based on 16 weeks of data from a single year. A more comprehensive source of commercial vehicle travel times could show different results with expanded coverage, but that source currently is not available in the region.

Table 3.8 Truck TTI and truck PTI on regional roadways (2016)

Road network	TTI	PTI
Overall	1.09	1.26
Interstate	1.06	1.15
Non-interstate	1.45	2.80

Source: PAG analysis of ATRI truck GPS data

Overall, the region's transportation system performs well in terms of TTI and PTI, primarily because the measures are weighted by volume, and most travel occurs on the region's interstates. As can be seen in **Table 3.8**, the commercial vehicles traveling on the region's interstates experienced reliable travel conditions and minimal congestion in 2016. This is consistent with feedback PAG received from private shippers and carriers, who stated that the region's interstates were adequately meeting their needs.

Non-interstate roadways in the region experience considerably higher peak-hour commercial vehicle delay and much lower reliability than the interstates. The poorer performance is a function of the effect that traffic signals have on traffic flow, likely compounded by the disproportionate share of the region's travel that occurs on the non-interstate system. Nonetheless, TTI and PTI for the region's non-interstate roadway network is within a reasonable range for interrupted flow facilities.[54]

Individual corridors will perform better or worse than the regional weighted average. **Figure 3.15** shows TTI on the regional non-interstate network. The majority of the network is currently performing in the "moderate" to "good" categories.

Figure 3.16 shows PTI on the regional non-interstate network. Again, most of the regional network is performing in the "moderate" to "good" categories regarding freight reliability, with the notable exception of the approaches to some intersections.

Though the region's roadways are currently serving the needs of freight, without ongoing investments in the transportation system, congestion is projected to increase on the region's arterial road network, including on many corridors important to freight movement. **Figure 3.17** shows modeled peak-hour congestion on the region's roadways in 2045 if no capacity is added to the system. The corridor segments shown in red would experience severe congestion, which would increase delays for both travelers and freight. Multiple projects are in the region's long-range plan to improve many of these corridors, but funding is not guaranteed.

Roadway Safety

Nationally, large trucks crashes disproportionately result in fatalities, though they represent only a small number of overall crashes on the public roadways. In 2015, trucks were involved in 8 percent of fatal crashes, but only in 3 percent of injury crashes and 4 percent of property-damage-only crashes.[55] The high fatality rate for truck crashes is a result of the heavy weight of the trucks and the difference in weight between trucks and passenger vehicles. The clear majority of fatalities are to occupants of the smaller passenger vehicles. The rate of fatalities in large truck crashes was 28 percent higher than the national rate for all vehicle types in 2015 (1.45 fatalities per 100 million VMT for trucks compared to 1.13 fatalities for all vehicle types). It is worth noting that a 2013 study by the American Trucking Association attributed the fault in truck crashes to the driver of the passenger vehicle in an estimated 70 percent to 75 percent of incidents.[56]

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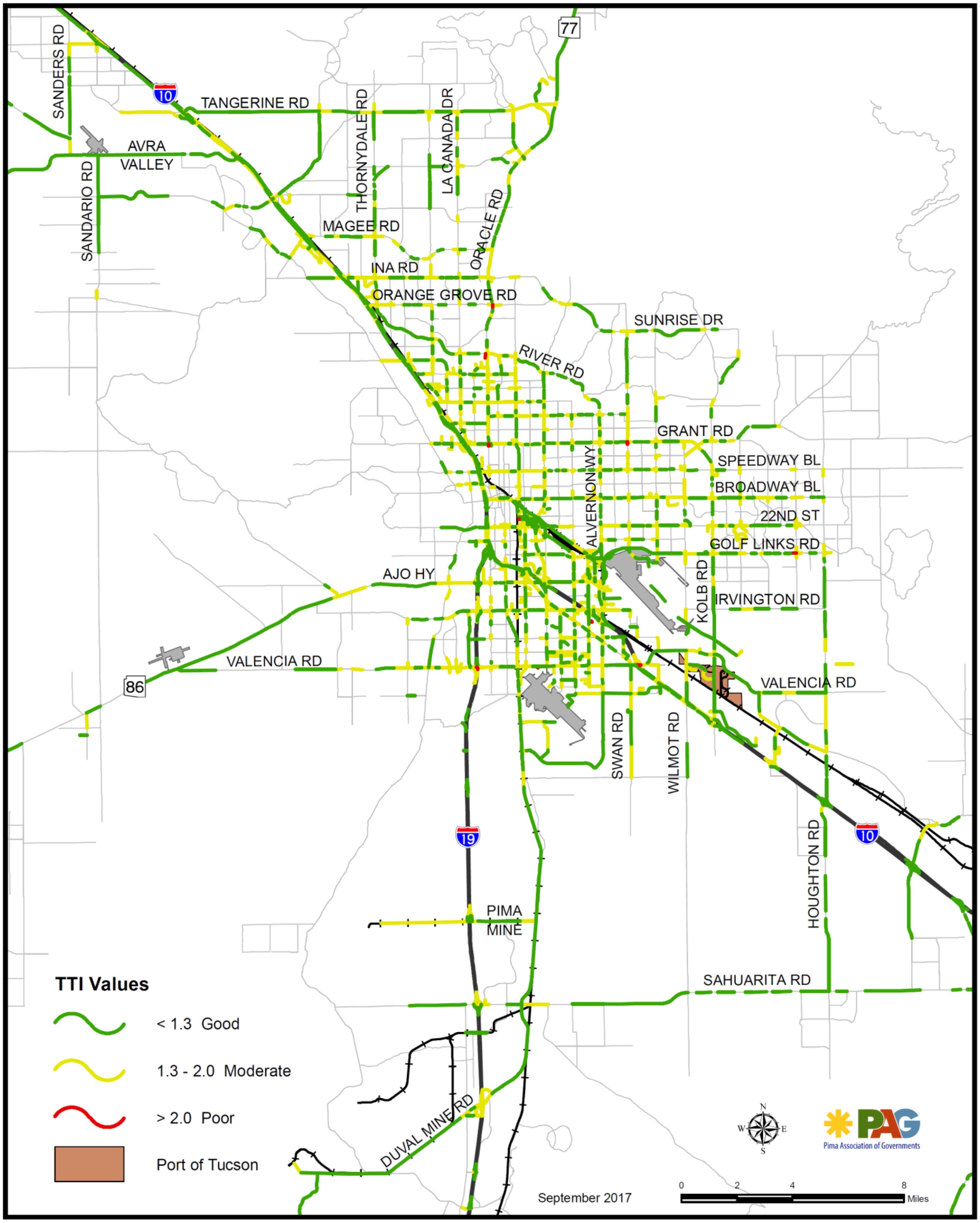
[54] Note: The thresholds used in the evaluation of TTI and PTI on interrupted and uninterrupted flow facilities are consistent with those used by ADOT in the *I-19 Corridor Profile Study*.

[55] U.S. Department of Transportation. National Highway Traffic Safety Administration. National Center for Statistics and Analysis (NCSA) Motor Vehicle Traffic Crash Data Resource Page. https://crashstats.nhtsa.dot.gov/#/.

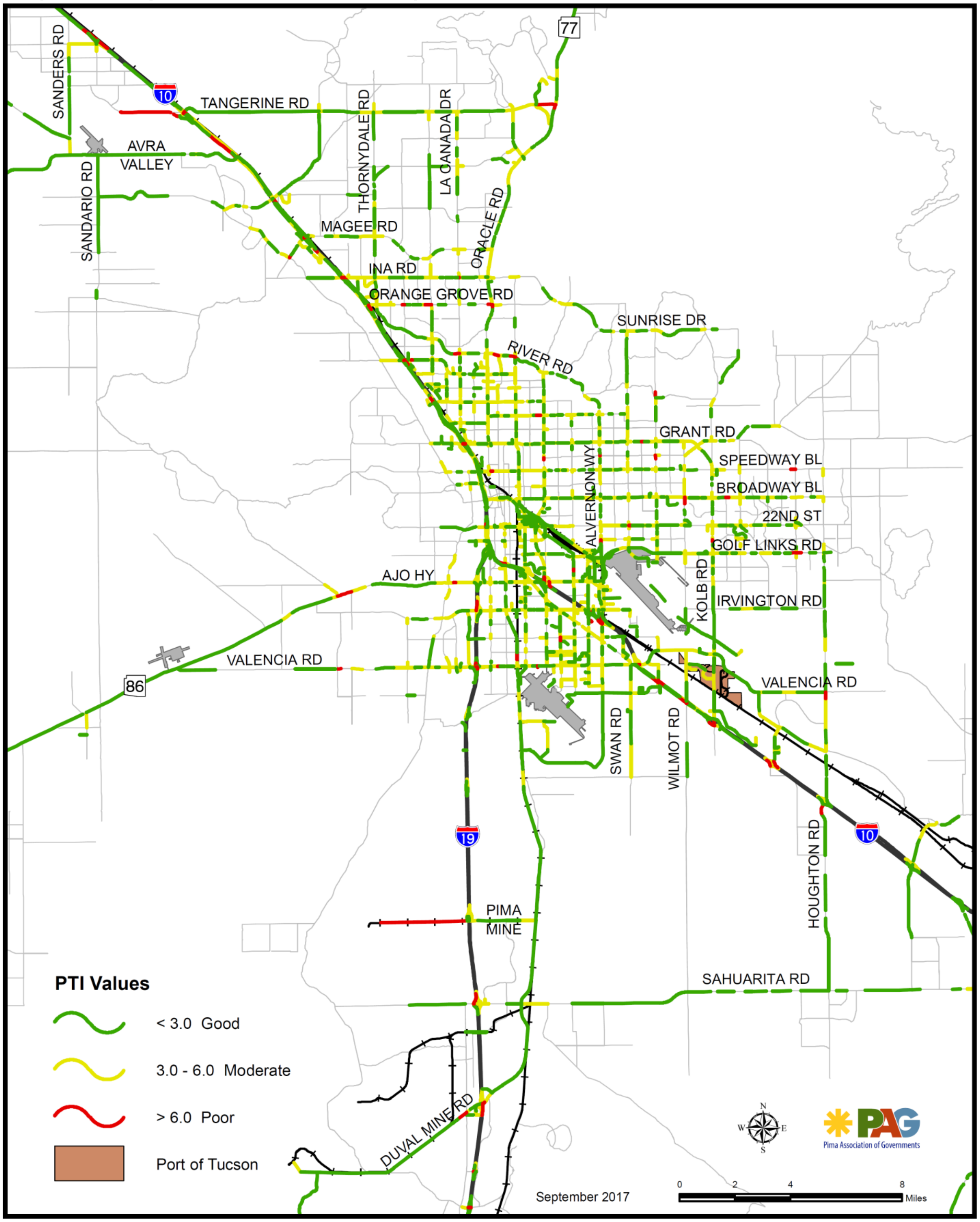
[56] American Trucking Association. Relative Contribution/Fault in Car-Truck Crashes. February 2013. http://www.trucking.org/ATA%20Docs/News%20and%20Information/Reports%20Trends%20and%20Statistics/02%2012%2013%20--%20FINAL%202013%20Car-Truck%20Fault%20Paper.pdf.

Figure 3.15 Recurring peak-hour truck delay on non-interstate roadway segments (based on truck TTI)



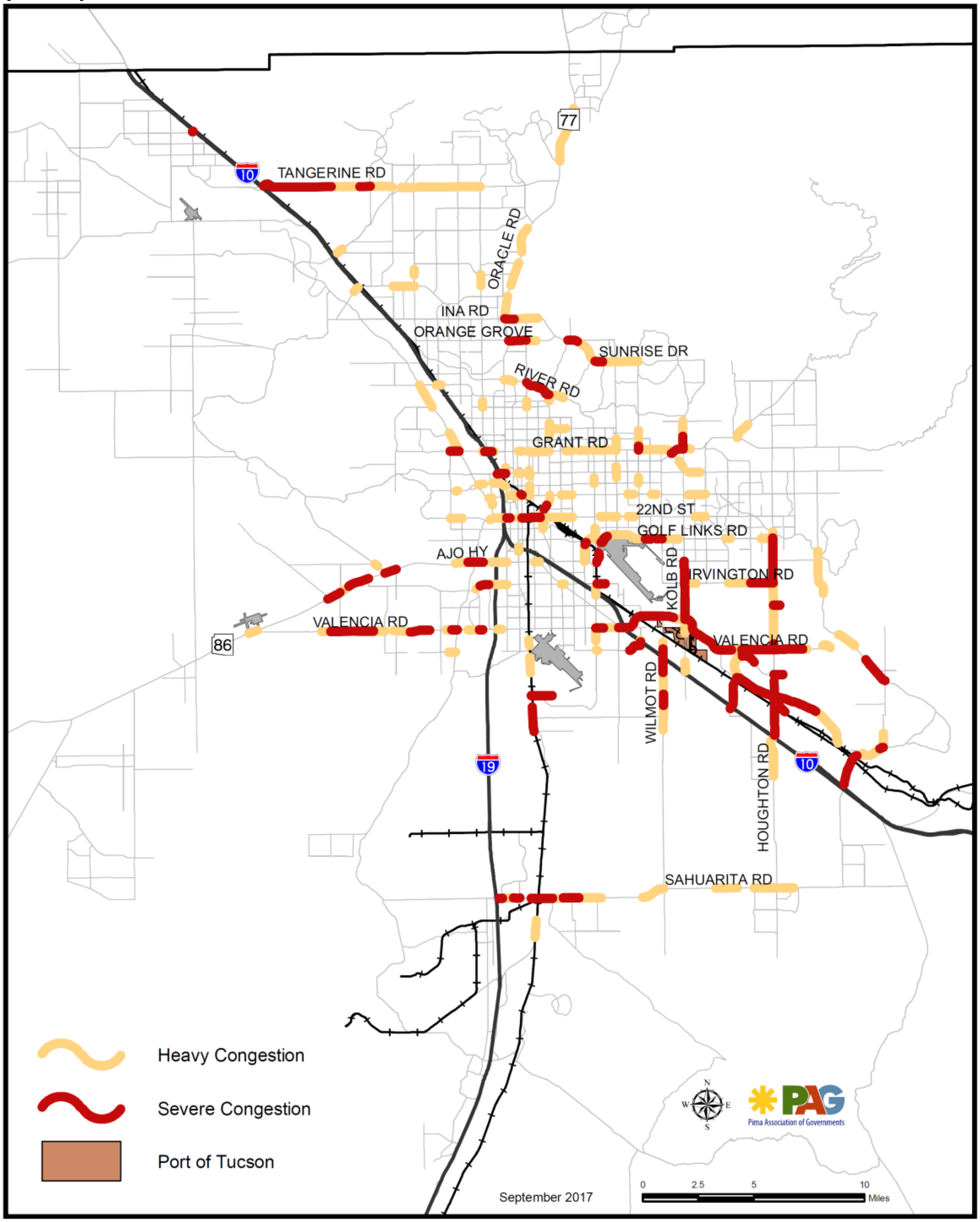
Source: PAG analysis of ATRI truck GPS data

Figure 3.16 Peak-hour freight reliability of non-interstate roadway segments (based on truck PTI)



Source: PAG analysis of ATRI truck GPS data

Figure 3.17 Projected non-interstate congestion – without projects (2045)



Source: PAG travel demand model

In Pima County, incapacitating crashes involving heavy vehicles are comparable to the national average, while fatal crashes are slightly lower. A comparison of Pima County with the state total shows that heavy vehicles are involved in a smaller share of fatal and incapacitating crashes than the state as a whole (5 percent in Pima County versus 10 percent statewide) (**Table 3.9**).[57] Because of this lower share, heavy vehicle crashes were not identified as a safety focus area in PAG's Strategic Transportation Safety Plan. The lower share could be a function of the relatively limited number of freeway miles in the region, as serious crashes are more common on heavily used interstate freight corridors.

Although heavy vehicles, including freight trucks, are not an identified safety focus area, trucks do account for a significant share of crashes on certain corridor segments. According to ADOT's I-10 Corridor Profile Study, two segments of I-10 in Pima County — through central Tucson and east of the SR 83 interchange — experience fatal and incapacitating crashes involving trucks at higher rates than the state average for similar operating environments (**Figure 3.18**).

Pavement Condition

In addition to capacity, reliability and safety, the condition of transportation facilities also affects how well freight moves in the region. After all, investment in maintenance of the system is an investment in both mobility and safety.

Preserving the transportation system has emerged as a national and regional transportation priority. Aging infrastructure continues to deteriorate, reducing the quality of the system and increasing maintenance costs. In fact, public input received during the development of the 2045 RMAP indicates that the condition of roadways is a primary transportation concern.

All roads deteriorate over time due to environmental conditions and the volume and type of traffic using the roadway. Without proper maintenance, roadways wear out prematurely. The rate at which deterioration occurs is a function of these factors, as well as the nature and frequency of preventative maintenance activities. Investing in repair and preservation actively reduces the scale of future costs. According to the American Association of State Highway and Transportation Officials (AASHTO), every $1 spent to keep a road in good condition avoids $6 to $14 needed later to rebuild the same road once it has deteriorated significantly. Deferred maintenance increases long-term taxpayer costs and accelerates the need for complete roadway rehabilitation, which can be four times as costly. Deferred rehabilitation also compounds the problem, often leading to pavement failure and the need to reconstruct the whole roadbed, which can reach 10 times the cost.

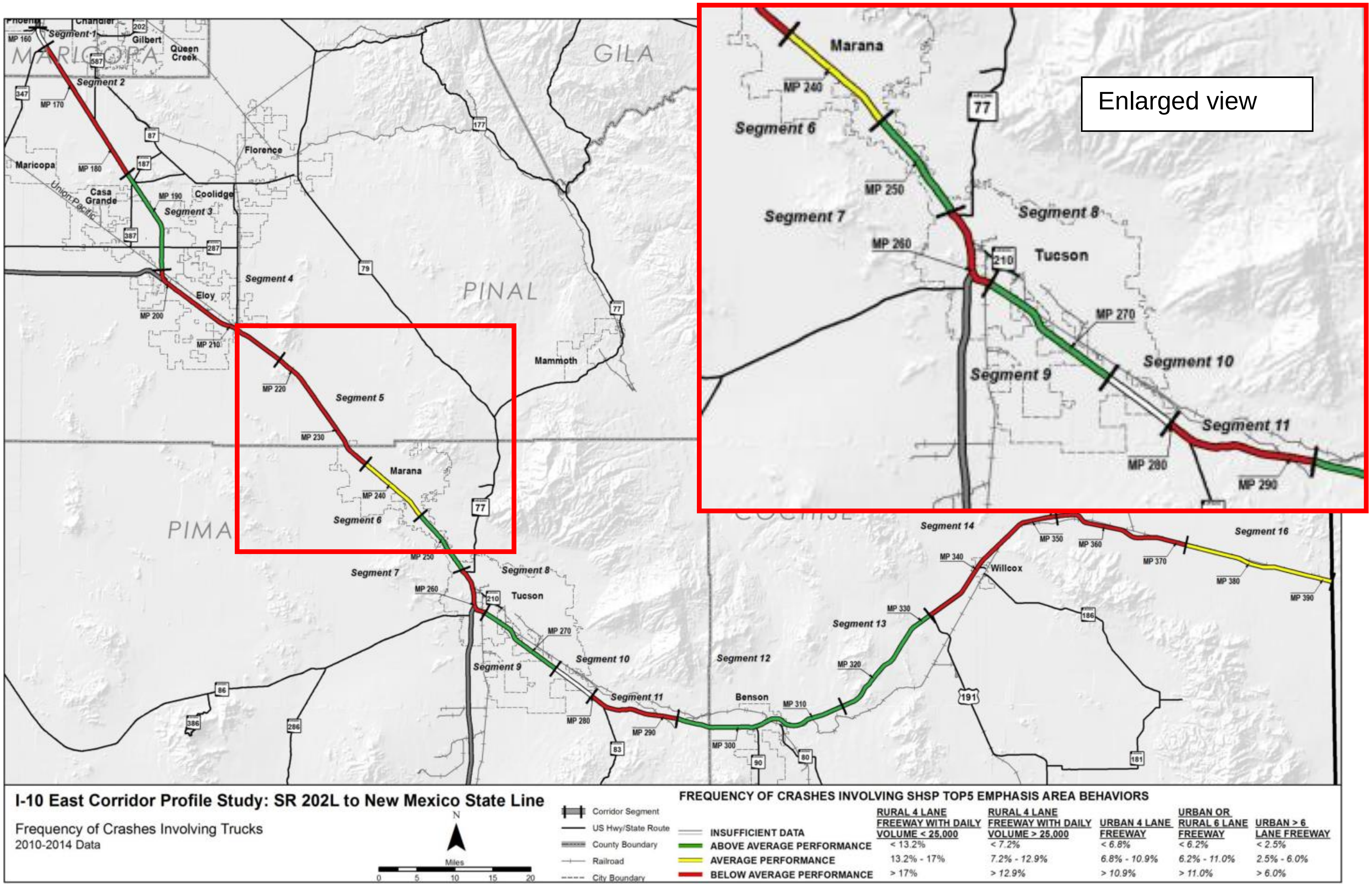
[57] Pima Association of Governments Strategic Transportation Safety Plan.

Table 3.9 5-year summary: Fatal and incapacitating crashes in PAG region

All Serious Crashes	Total Crashes		Crashes per 100 mil VMT		Percentage of Total	
	PAG	State	PAG	State	PAG	State
Intersections	1,286	9,161	3.08	3.04	41%	41%
Young Drivers	1,101	7,319	2.64	2.43	35%	33%
Speeding and Aggressive	851	7,291	2.04	2.42	27%	33%
Occupant Protection	699	6,075	1.68	2.02	22%	27%
Impaired Driving	673	4,852	1.61	1.61	21%	22%
Older Drivers	631	3,873	1.51	1.29	20%	17%
Road/Lane Departure	544	7,979	1.30	2.65	17%	36%
Motorcycles	542	4,298	1.30	1.43	17%	19%
Pedestrians	397	2,376	0.95	0.79	13%	11%
Distracted Driving	316	4,311	0.76	1.43	10%	19%
Bicycles	210	1,189	0.50	0.40	7%	5%
Heavy Vehicles	142	2,276	0.34	0.76	5%	10%
Weather - All	85	706	0.20	0.23	3%	3%
Weather - Precipitation	81	618	0.14	0.21	3%	3%
Work Zone	26	296	0.06	0.10	1%	1%
Animals	7	99	0.02	0.03	0%	0%
Weather - Dust/Wind	4	88	0.01	0.03	0%	0%
TOTAL	**3,138**	**22,289**	**7.52**	**7.41**		
Urban Areas	2,605	16,434	6.27	5.46	83%	74%
Rural Areas	533	5,855	1.28	1.95	17%	26%
Tribal Lands	113	965	0.27	0.32	4%	4%

Source: PAG Strategic Transportation Safety Plan

Figure 3.18 Fatal and incapacitating crashes involving trucks on I-10



Source: ADOT I-10 Corridor Profile Study

During the 2008 recession, preventative maintenance activities were often delayed due to reduced availability of funds, resulting in underfunding of the system and further roadway deterioration over that period.

PAG estimates that it could cost the region up to $3.6 billion over 30 years to bring most of the region's major roadways up to good condition and maintain them in a state of good repair. This includes the large, one-time costs to rehabilitate or reconstruct roadways as well as the ongoing expense of maintaining the assets over the life of the 2045 RMAP through pavement preservation. This estimate does not consider the condition of local and neighborhood streets, which are the sole responsibility of the owning jurisdictions and outside the scope of this plan.

In recent years, the region's jurisdictions have taken major steps to address the funding shortfall and improve the condition of the region's roads. The voters of the City of Tucson approved Propositions 409 and 101, committing funding to road preservation and maintenance in the City of Tucson; Pima County has made general fund contributions to pavement preservation and recently increased property taxes as a means of funding countywide improvements for local roads and streets. The Towns of Oro Valley, Sahuarita and Marana have continued to actively manage their pavement assets, using state-shared funds and local general funds to maintain facilities in good operating condition.

The regional commitment to improving road conditions has begun to pay off, with the share of non-interstate major roadways classified in poor condition falling from 53 percent to 37 percent between 2011 and 2016 (based on a measure of ride roughness, called International Roughness Index (IRI)). **Figure 3.19** shows the condition of major roadways based on the 2015/2016 collection of pavement data.

Pavement Condition and Freight

Poor pavement condition can hinder the ability of shippers to move goods easily to and from destinations and can add substantial cost to over-the-road carriers due to increased wear and tear on vehicles. In one recent example, FedEx CEO Fred Smith told the U.S. House Committee on Transportation and Infrastructure that FedEx now uses twice as many tires as it did 20 years ago because of the nation's deteriorating roadways.[58] Locally, a major export-oriented manufacturer indicated that they make routing decisions based on the conditions of specific roadways because poor ride quality can potentially damage shipments of sensitive, high-value electronic equipment.[59]

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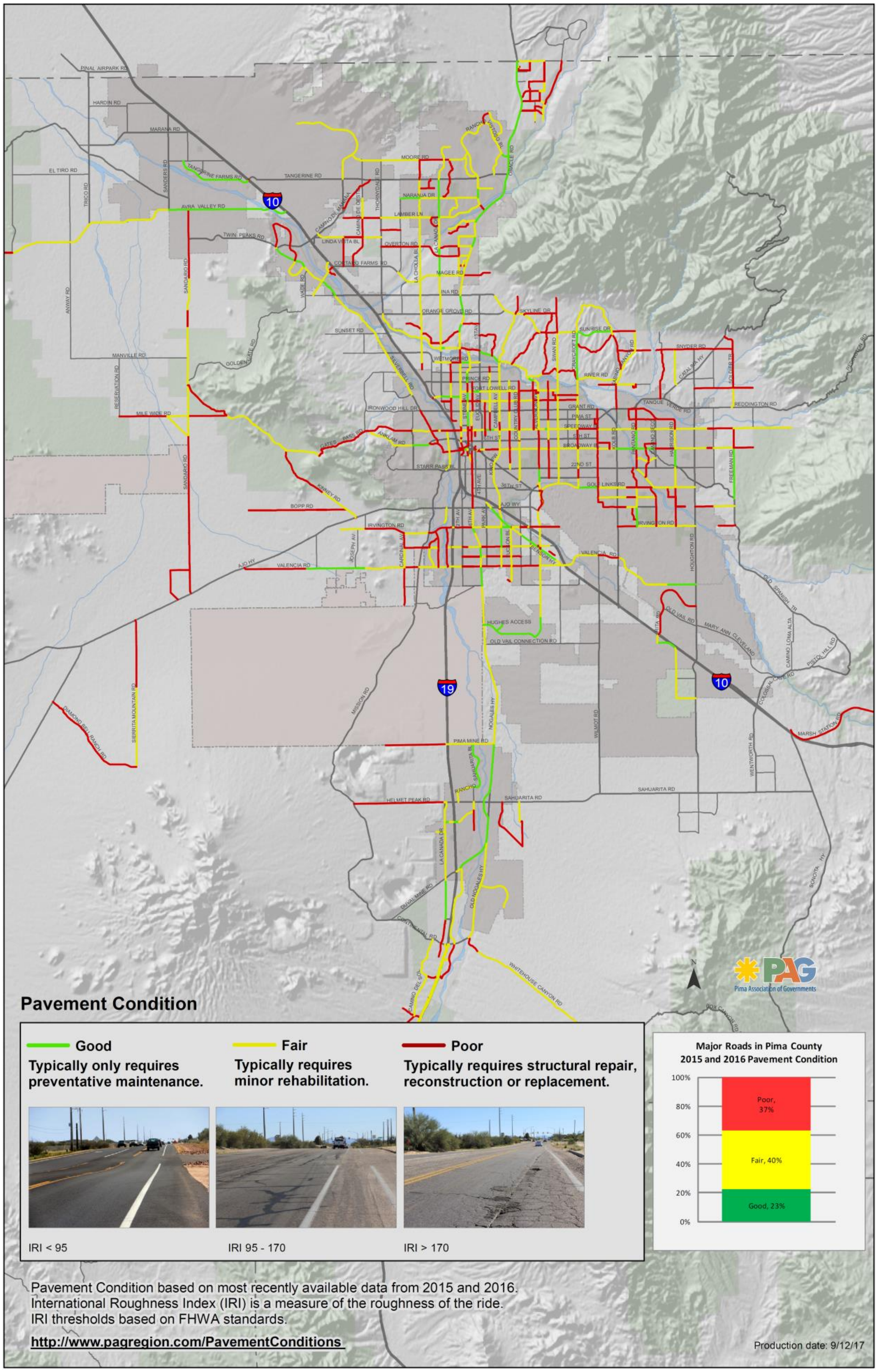
[58] Josephs, Leslie. "FedEx says US roads are so bad it's burning through tires twice as fast as it did 20 years ago". *Quartz*. 02/01/2017. https://qz.com/900565/fedex-says-us-roads-are-so-bad-its-burning-through-tires-twice-as-fast-as-it-did-20-years-ago/

[59] Based on PAG discussions with private freight producing industries conducted during the freight planning process.

Figure 3.19 Pavement condition of major roadways (2015/2016)



Source: PAG analysis of pavement data acquisition

Heavy trucks are responsible for a considerable share of pavement degradation. By one estimate, a fully loaded five-axle tractor trailer truck weighing 80,000 pounds does equivalent damage to pavement as 9,000 to 10,000 single-occupancy passenger vehicles.[60] And while not all trucks weigh in at the 80,000-pound federal limit, because they travel empty or with less-than-full loads, they still contribute significantly to the deterioration of roadways.

The 2045 RMAP recommends that the region commits $3.18 billion over the next 30 years for pavement preservation. While this does not fully address the estimated need, this amount represents a significant increase over past plans and reflects the public's concern about the state of the region's roadways. Failure to proactively address pavement needs will lead to increased future costs, higher vehicle repair bills for shippers, a reduction in the region's economic competitiveness and decreased function of the transportation system overall.

Weight Restricted Bridges

Eastern Pima County has more than 1,000 bridges and culverts, structures that are critical for regional mobility because they enable vehicles, bicycles, pedestrians and wildlife to cross obstacles. More specifically, culverts are structures designed to manage water flow at rivers and washes, while bridges are structures that span more than 20 feet between supports.

Like roads, bridges and culverts deteriorate over time due to weather and normal wear-and-tear with the passage of vehicles. The bridges and culverts in the PAG region vary greatly in their age, averaging 40 years. Approximately 120 bridges and culverts have been replaced or constructed since 2000. Due to the mild nature of the region's climate, bridges have a long lifespan and can easily exceed 50 years of service. To ensure safety and minimize disruption to the transportation network, these structures undergo regular inspections by qualified engineers. Inspections help locate and identify potential problems early and trigger protection mechanisms when a problem is found.

When significant structural issues are found on a bridge, the owning agency can post a weight limit. Lowering the maximum allowable weight across the structure maintains its safety and usefulness for most users, since much of the wear and tear on a bridge or culvert is the result of repeated stress from heavy loads. A consequence of a weight limit, however, is the rerouting of heavier vehicles, typically commercial trucks and buses, resulting in longer travel times, more miles traveled and ultimately higher costs for the affected users. The added functional life that is gained by posting a weight limit can help the owning agency secure the funding necessary to make the needed repairs

[60] Mid-Ohio Regional Planning Commission. Central Ohio Freight Fact Book. 08/2004 http://www.morpc.org/pdf/Truck_Freight.pdf.

or replace the structure. Currently, an estimated 16 non-federally owned structures in the region have posted weight limits or other restrictions.

Freight Rail

Railroad is the second most common means by which goods flow into and out of the PAG region, carrying 21 percent of outbound freight and 6 percent of inbound freight. The region is served by a single common freight carrier, Union Pacific Railroad (UPRR), which owns more than 690 miles of track in Arizona.[61] The PAG region is located at the juncture of the 760-mile Sunset Route, connecting Los Angeles to El Paso, and the 65-mile Nogales Subdivision, which connects the Sunset Route mainline to the Nogales Port of Entry, providing rail access to Mexico. The Nogales Subdivision ties into the Sunset Route mainline southeast of downtown Tucson, near where Euclid Avenue passes under SR 210 on the approach to the Tucson classification yard. Union Pacific is the largest Class I railroad in the United States by value, operating more than 32,000 miles of track in 23 states. Tucson is Union Pacific's principal terminal in Arizona.

Freight rail assets include the Union Pacific Tucson Classification Yard, the Port of Tucson full-service inland port and rail-to-truck intermodal facility, and railroad spurs connecting directly to the ASARCO Mission mine and the Freeport-McMoRan Sierrita mine.

Union Pacific Sunset Route

The Union Pacific Sunset Route roughly follows the Interstate 8 (I-8) and I-10 corridors and connects the PAG region to Southern California, the Ports of Long Beach and Los Angeles, El Paso and Dallas, Texas, and points farther north and east. Approximately 20 percent of UPRR's total traffic is carried on the Sunset Route, much of which is marine containers and construction materials.[62]

About 40 percent of containers at the Ports of Long Beach and Los Angeles are loaded onto freight trains, divided among two Class I carriers: Burlington Northern Santa Fe (BNSF) Railroad and UPRR.[63] BNSF, which connects Los Angeles/Long Beach to Chicago, is the busier of the two. It sends around 100 trains a day on average through northern Arizona on the Transcon Corridor. UPRR moves 40 to 50 trains per day

[61] Union Pacific. "Union Pacific in Arizona". 2017. https://www.up.com/cs/groups/public/@uprr/@corprel/documents/up_pdf_nativedocs/pdf_arizona_usguide.pdf.
[62] Ibid.
[63] Caltrans. Freight Planning Fact Sheet: Port of Long Beach. 07/2012. http://www.dot.ca.gov/hq/tpp/offices/ogm/ships/Fact_Sheets/Port_of_Long_Beach_Fact_Sheet_073012.pdf.

through the PAG region on the Sunset Route, equal to about one train every 30 minutes.[64] The Sunset Route carries more than 160,000 carloads annually.

Union Pacific Nogales Subdivision

The other significant railroad facility in southern Arizona is the Nogales Subdivision. The Nogales Subdivision is a branch line of the Sunset Route and is one of six rail gateways to and from Mexico operated by UPRR. The border area contains an interchange with Ferromex supporting cross-border freight rail movements. The Nogales Subdivision runs roughly parallel to I-19 between Tucson and Nogales. In the PAG region, the tracks are located next to Nogales Highway.

Generally, six to eight trains per day travel on the Nogales Subdivision.[65] One of the primary commodities carried by trains traveling out of Mexico is automotive products from Ford Motor Company's Hermosillo plant, many of which are destined for the Upper Midwest.[66]

Rail Commodities

The rail mode excels at moving bulk goods over long distances, where trains can provide a cheaper and more energy-efficient freight option. But because rail is less flexible and can't often make first- or last-mile pick-ups or deliveries without a transfer to another mode, rail's advantages are lost for shorter or medium-distance trips and mixed cargo.

The top commodities moving through Arizona by UPRR include intermodal wholesale, automobiles, general merchandise (such as imports carried in marine containers), chemicals, lumber, coal and petroleum products, and Portland cement. In terms of rail flows into and out of Pima County, copper is the dominant commodity, accounting for more than 80 percent of outbound freight rail value. Metal products and chemical preparations are the most common commodities transported into the region by rail.

Rail Infrastructure Performance

Approximately two-thirds of the Sunset Route is currently double-tracked, including the mainline through the PAG region. The Nogales Subdivision is single-tracked between Tucson and Nogales. According to a Working Paper of the Arizona State Freight Plan, the Class I network is in good operating condition and provides adequate capacity to meet current demand for freight rail service.

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[64] CPCS. Arizona State Freight Plan: Phase 2 Working Paper Inventory of State Freight Transportation System Assets. 09/11/2015. https://www.azdot.gov/docs/default-source/planning/State-Freight-Plan/14325-arizona-state-freight-plan---phase-2-draft-working-paper---state-freight-system-(mpd-085-14).pdf?sfvrsn=0.

[65] ADOT. "Arizona State Rail Plan". 03/2011 http://www.azdot.gov/docs/planning/state-rail-plan.pdf.

[66] The University of Arizona, Eller College of Management Economic and Business Research Center. "Arizona-Mexico Economic Indicators Annual Report 2016". 05/2016. https://azmex.eller.arizona.edu/sites/azmex/files/Report/azmex-annual-report-2016-final.pdf.

Over the last 20 years, Union Pacific has doubled the share of the Sunset Route that is double-tracked. The company will continue to invest in double tracking to meet expected growth of rail demand in the coming decades.

Rail Safety

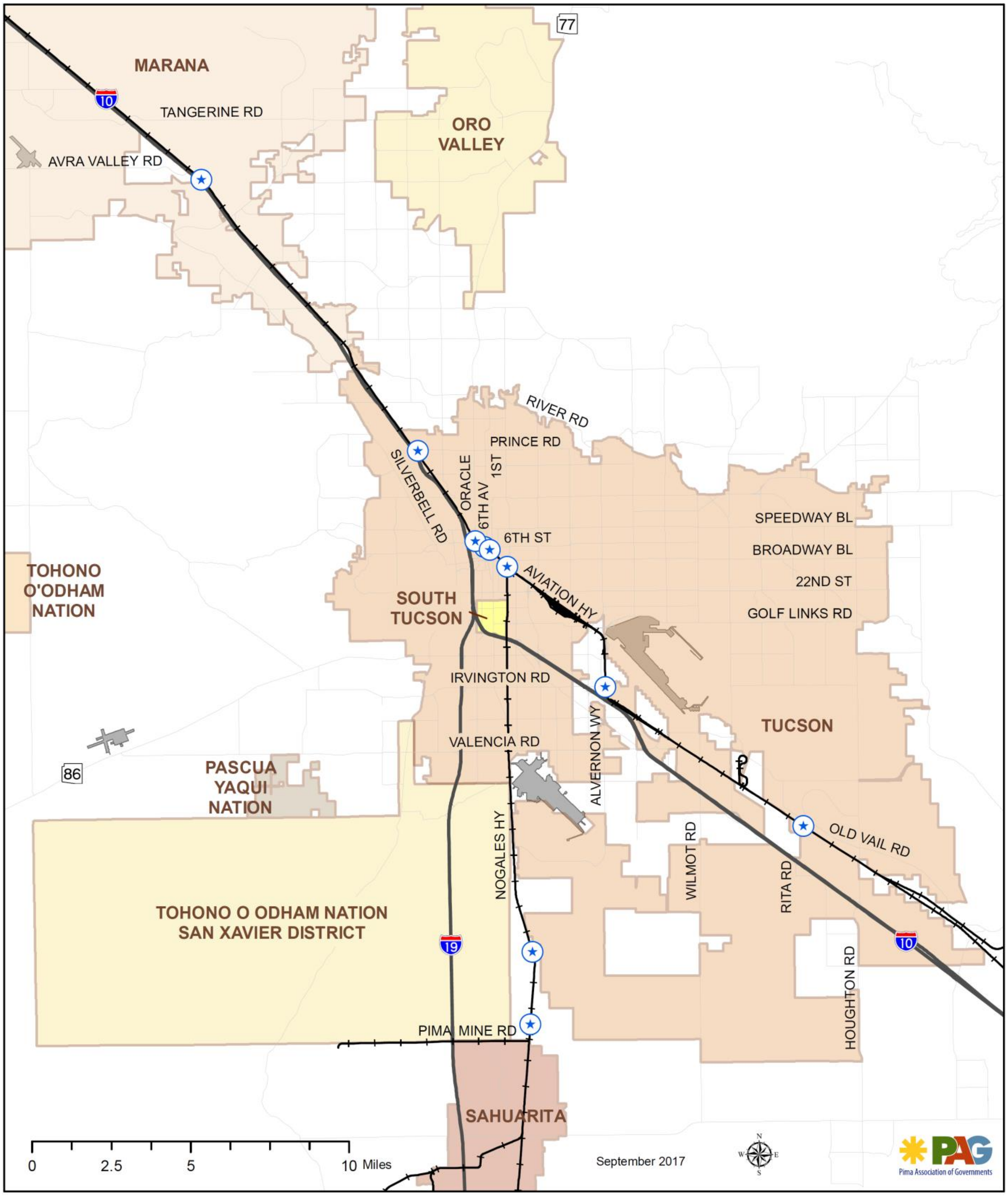
Between 2011 and 2015, nine highway-rail incidents occurred between trains and road users in Pima County, an average of fewer than two per year. Two of those nine crashes resulted in fatalities, while one resulted in injury.[67] [68] Considering that there are approximately 10,000 reported vehicle crashes *each year* in Pima County resulting in nearly 90 fatalities and 4,000 injuries, rail incidents are not a significant contributor to roadway safety issues. However, these are preventable deaths and injuries and should be minimized or eliminated whenever possible. Crashes are scattered throughout the PAG region, though there is a slight clustering in the downtown area (**Figure 3.20**).

Moreover, in addition to the human cost, rail incidents also cause major delays and reliability issues on the rail system. A crash in Tucson that requires a detailed police investigation can cause backups along the line all the way to Los Angeles. Most, though not all, of these incidents occur where there are rail crossings at street level. At-grade crossings create potential safety conflicts with road users, create delays for the traveling public and can slow down trains through populated areas. The region has approximately 76 at-grade rail crossings, with some of these crossing major arterials.

[67] Federal Railroad Administration, Office of Safety Analysis. http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx.

[68] Highway-rail incident data do not include suicides, attempted suicides, or incidents that result from trespassing on railroad property. Suicide data are not required to be reported to the FRA as per the *FRA Guide for Preparing Accident/Incident Reports.* Trespasser injuries and deaths are reported separately from highway-rail incidents. From 2011-2015 there were nine railroad trespasser deaths and four trespasser injuries not at highway-rail crossings in Pima County.

Figure 3.20 Highway-rail incidents, 2011-2015



Source: PAG analysis of Federal Railroad Administration Accident tables

Port of Tucson

The Port of Tucson is a strategic asset integral to achieving the region's goal of becoming an important distribution and logistics center. As the region continues to expand in population and jobs, this facility will provide access to the global market for manufacturers and commodity exporters, thereby increasing Arizona's economic competitiveness.

Founded in 1996, the Port of Tucson (Port) is a privately held and locally owned inland intermodal container rail export facility that supports international trade. The 770-acre facility, located near the intersection of Kolb and Valencia roads, is a vital transportation and logistics center for southern and central Arizona and the only intermodal facility in the state certified as a foreign trade zone for direct delivery and origination of international containers.

Over the past decade, the Port has expanded and developed its assets to include more than 1.8 million square feet of improved space, refrigerated storage and distribution, intermodal capabilities, a full-service chassis yard, rail-served and rail-dock-served buildings, in-port trans-loading and locomotive services, 10 miles of loop track and a high-speed transfer switch. Some of these improvements were funded through a $5 million federal Transportation Investment Generating Economic Recovery (TIGER) grant awarded to the Port in 2013.

The Port's facilities are part of a national and global transportation system, which includes the Tucson-Phoenix megapolitan area (Sun Corridor) and Mexico. With its proximity to the U.S.-Mexico border and connection to Union Pacific's Sunset Corridor main line, the Port provides a vital connection to global economies in Asia, Europe and elsewhere. Moreover, the Port sits only minutes from air service via the Tucson International Airport and is adjacent to I-10, the southernmost cross-country interstate highway and a major freight corridor. In 2016, the Port conducted an average of 1,275 container lifts per month and processed more than 3,200 train cars carrying products, including sugar, beverages, acid and propane.

Planned Projects

Most railroad projects are planned, paid for and executed by private owners of the facilities. The exception is roadway grade-separation projects.

Union Pacific Sunset Route

UPRR has an ongoing effort to lengthen trains along many corridors. This effort allows for more efficient movement of trains, less congestion and less trains moving across the system. Modifying infrastructure, such as lengthening sidings and adding double track in specific areas, helps achieve this goal of lengthening trains.

To meet this goal, UPRR invested more than $400 million in infrastructure in Arizona between 2012 and 2016.[69] Going forward, the railroad will continue to double-track the Sunset Route main line, as necessary, and lengthen sidings to accommodate future rail demand and longer trains.

Air Cargo – Tucson International Airport

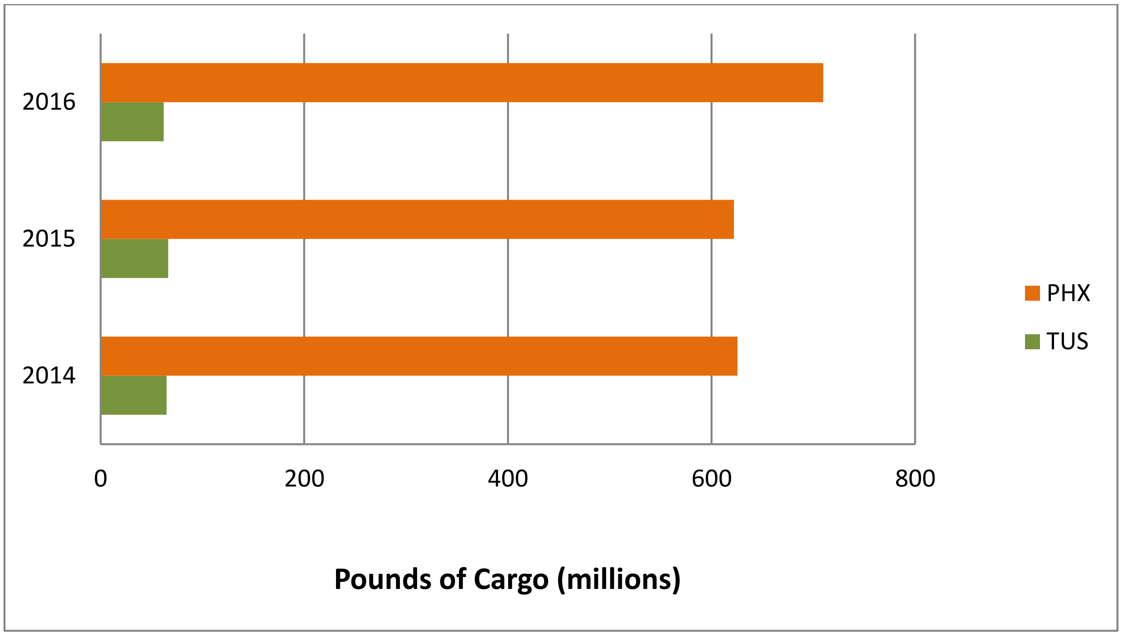
TUS is located on 8,343 acres eight miles south of downtown Tucson and operated by the Tucson Airport Authority (TAA). Approximately 2,000 acres are currently developed for aeronautical use. The remaining on-airport land is vacant, underdeveloped or not currently used for aeronautical purposes. Tucson International Airport is one of two anchor air cargo airports in the state, the other being Phoenix Sky Harbor International Airport in Phoenix, and is the principal airport serving metropolitan Tucson, southern Arizona and northern Sonora, Mexico. TAA has a long-term lease with the City of Tucson to operate and manage both Tucson International Airport and Ryan Airfield, a general aviation airport west of Tucson. Tucson International Airport is also a U.S. Port of Entry airport with U.S. Customs and Border Protection services, which operate continuously 365 days per year.

Air Cargo at Tucson International Airport

Tucson International Airport is the region's primary air cargo facility, servicing the air freight needs of not only Pima County but also most of southern Arizona, including Nogales. To this end, the airport maintains air cargo terminals of 16,000 square feet and 45,000 square feet as well as a dedicated FedEx air cargo terminal, which comprises 15,000 square feet of dedicated space. Despite Tucson International Airport being the air freight hub of southern Arizona, the bulk of air cargo and passenger travel occurs at Sky Harbor. For comparison, in 2016, Tucson International Airport moved more than 60 million pounds of air cargo while Sky Harbor moved more than 600 million pounds of air cargo (**Figure 3.21**). The Phoenix metro area is significantly larger in size, and Sky Harbor hosts companies with significant air cargo needs, such as UPS, the U.S. Postal Service and DHL. A large amount of air cargo moves into and out of Sky Harbor before being transported by truck to the Tucson area. Occasionally, outbound air cargo is transferred from Phoenix to Tucson, due to full planes or adverse weather conditions.

[69] Union Pacific. "Union Pacific in Arizona". 2017 https://www.up.com/cs/groups/public/@uprr/@corprel/documents/up_pdf_nativedocs/pdf_arizona_usguide.pdf.

Figure 3.21 Air cargo activity at Phoenix and Tucson Airports[70]



Most of the cargo at Tucson International Airport is transported by integrated cargo carriers, which are fully dedicated to transporting cargo. The single major air cargo carrier operating at the airport is FedEx, which transports express freight and packages out of its own air cargo terminal with daily flights between Tucson and its primary domestic sorting facility in Memphis, Tenn. Other, air cargo carriers operating at the airport include Matheson Flight Extenders Inc. and a variety of other smaller companies. In addition to dedicated integrated cargo carriers, other cargo is transported in the cargo hold of passenger aircraft and referred to as "belly cargo." Air carriers providing belly cargo services include American Airlines, Delta Air Lines and Southwest Airlines.

One of TAA's primary goals is to promote compatible land uses to preserve and grow major employment centers while also leveraging reasonable revenue-generating opportunities. Significant companies, such as Raytheon, Securaplane Technologies Inc. and others, regularly use the air cargo facilities at Tucson International Airport. The items produced and shipped by these varied businesses are often of high value, weigh little, and are time- and temperature-sensitive — ideal attributes for air cargo shipments. FedEx or other scheduled chartered air cargo services are typically used.

In 2015, in an effort to protect and help the region's largest private employer, Raytheon, TAA and the U.S. Air Force (USAF) worked with Pima County in a land exchange to create a buffer around Raytheon that would mitigate future threats to its operational

[70] Phoenix Sky Harbor Airport. Airport Statistics. https://www.skyharbor.com/About/Information/AirportStatistics and Tucson Airport Authority. Comprehensive Annual Financial Report. https://20532-presscdn-pagely.netdna-ssl.com/files/2016-TAA-CAFR.pdf.

flexibility. This included the abandonment of Hughes Access Road and the construction of the Aerospace Parkway, a new 2.5-mile-long roadway approximately 2,500 feet south of the now abandoned Hughes Access Road. The new roadway enables expansion of the Air National Guard's 162nd Fighter Wing at TIA and provides the ability to continue development of the Aerospace, Defense and Technology Research and Business Park. Additionally, it creates room for construction of a second runway at Tucson International Airport and for TAA to more easily develop land for revenue-generating purposes consistent with its currently approved Airport Layout Plan (ALP).

Virtually all U.S. airports, including Tucson International Airport, track total cargo volume on a directional (inbound/outbound) basis. However, the airports do not have the ability to track the commodity type of air freight cargo moving into and/or out of their facilities nor to their origin/destination. Interviews conducted by PAG with regional shippers and manufacturers revealed that the majority of air cargo consists of high-tech, high-dollar items and time-sensitive shipments. Additionally, commodity flow data (TRANSEARCH) purchased by PAG for development of the Freight Plan provided valuable insight into commodity flows at Tucson International Airport. In-depth analysis of the TRANSEARCH data by consultants supports the statements of the shippers and manufacturers. According to the report, the top commodity categories for freight outflows by air are electronics and electrical equipment, and precision instruments. By tonnage, the top commodity is largely small package shipments. For freight inflows, the top commodity categories are electronics and electrical equipment, and transportation equipment (missiles manufactured by Raytheon).

Future Development

TAA has an aggressive economic development function, which includes targeted recruitment of new businesses and industry. TAA expects a high percentage of the companies expanding to Tucson International Airport to use its air cargo facilities. In that respect, the airport has vacant cargo facilities and land for development of new air cargo facilities that are available to logistics-related businesses and developers. The airport also has partnered with Pima County to attract businesses to continue the development of the Aerospace Research Campus. Furthermore, the airfield can accommodate cargo aircraft of virtually any type and size.

TAA has identified a series of recommended projects to improve the movement of aircraft at Tucson International Airport. These improvements include the relocation and reconstruction of its main runway, construction of a new center parallel taxiway and implementation of several safety elements. These improvements are intended to improve safety by reducing the number of airfield incursions, or occurrences involving the incorrect presence of an aircraft, vehicle or person on the area designated for landing and take-off of aircraft. TAA submitted the projects to FAA through its ALP, which was approved by FAA pending an EIS, which is currently underway.

Despite the availability of developable lands and existing infrastructure, lack of rapid and direct access to the airport from I-10 is a hindrance for freight into and out of the airport. The programmed construction of a new traffic interchange at Country Club Road could help to address this issue. Moreover, the current alignments of Swan Road and Alvernon Way are in direct conflict with the location of Tucson International Airport's future parallel runway. Therefore, according to TAA, in order to fully capitalize on cargo opportunities at the airport, these roads will need to be realigned to allow for future growth.

Pipeline – Kinder Morgan

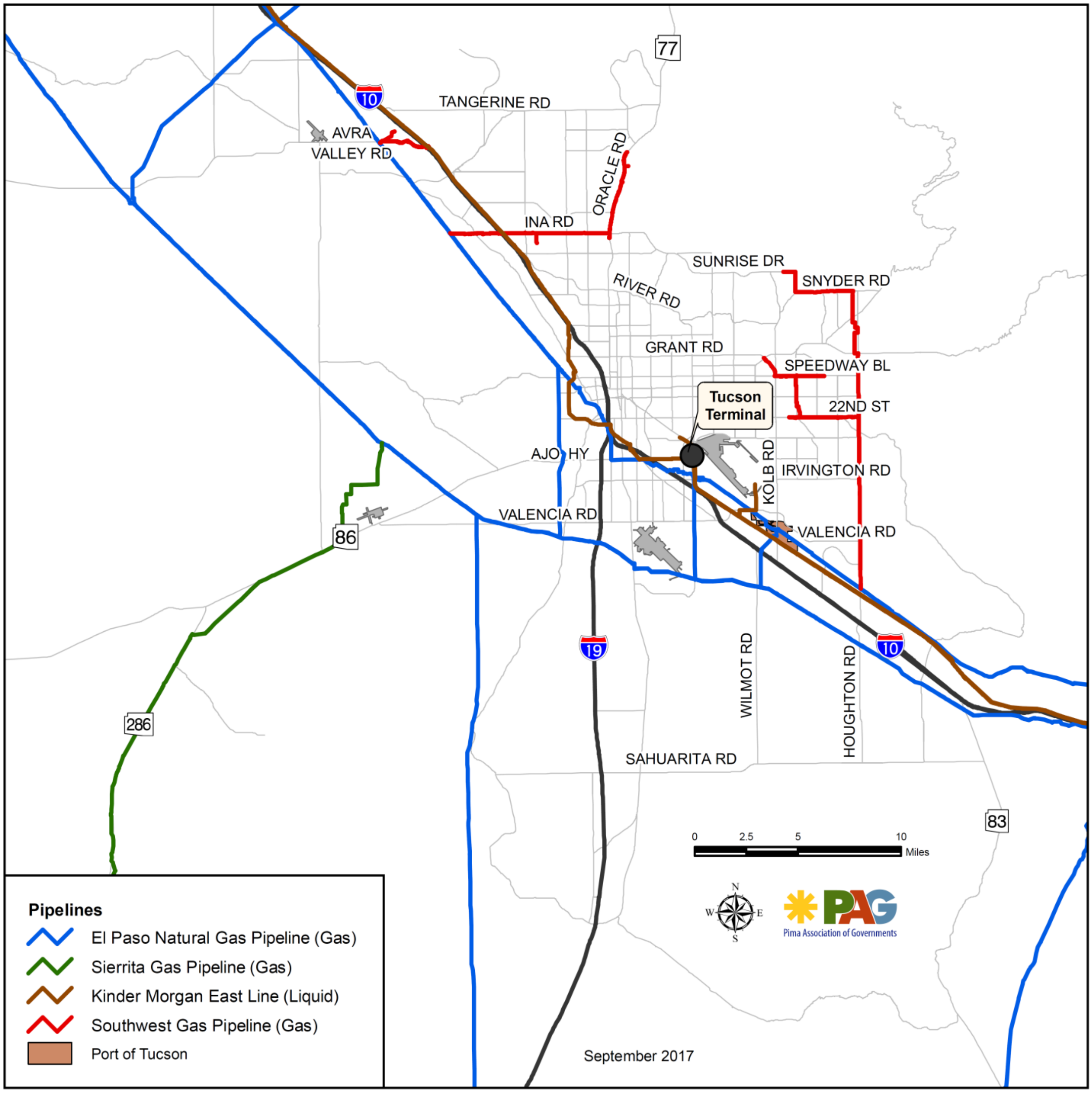
The PAG region is located on two major interstate pipelines; the El Paso Natural Gas pipeline and the Kinder Morgan SFPP system "East Line" (formerly the Santa Fe Pacific Pipeline). The El Paso Natural Gas pipeline transports natural gas from the Permian, Andarko and San Juan basins in West Texas and northern New Mexico via Arizona to major markets in California. The Kinder Morgan "East Line" moves refined petroleum products from El Paso, Texas, to Tucson and Phoenix. **Figure 3.22** shows the location of major pipeline infrastructure in the PAG region.

Like railroads, pipeline infrastructure is owned and operated by private companies, which are responsible for investment decisions and performance considerations. However, pipelines are heavily regulated by the federal government. Pipeline safety is overseen by the Pipeline Safety and Hazardous Materials Safety Administration; transmission rates are set by the Federal Energy Regulatory Commission.

El Paso Natural Gas Pipeline

Natural gas moves from the well to the end user through a system of gathering pipelines, transmission pipelines and distribution pipelines. The gathering system moves natural gas from the well head to the processing plant. From the processing plant, the gas enters the transmission system for interstate transport to the destination market. Once at the destination market, gas passes through the delivery point to the distribution system, where it is taken over by the local utility. The distribution system moves gas through the community and delivers it to the end consumer, usually residences and businesses.

Figure 3.22 Pipeline infrastructure by type



Source: National Pipeline Mapping System

The El Paso Natural Gas transmission pipeline (owned by Kinder Morgan) is the interstate transmission line that serves the PAG region. And while most of the gas traveling through the line is destined for the large California markets, the El Paso Natural Gas pipeline provides a vital source of energy for local consumers. Roughly 70 percent of natural gas consumed in Arizona is used in the production of electricity.[71] This includes the Tucson Electric Power (TEP) Sundt Generating Station located off East Irvington Road. TEP made the full transition to natural gas in 2015 after depleting the last of its coal inventory.[72] TEP receives natural gas directly off the El Paso transmission line for use in power generation. Most residential and commercial consumers in the PAG region receive their gas through the distribution system from Southwest Gas.

In recent years, natural gas pipeline exports to Mexico have grown at a rapid pace, more than doubling in the past five years.[73] To provide additional capacity to support growing exports, Kinder Morgan installed the Sierrita pipeline southwest of Tucson, which was brought into service in October 2014. The approximately 60-mile pipeline provides 200,846 dekatherms per day (Dth/d) of capacity and extends from the El Paso Natural Gas south main lines to the border near Sasabe, Arizona.

Natural Gas Capacity

As of the writing of this Freight Plan, Kinder Morgan was planning to expand capacity on the Sierrita pipeline to provide additional gas to Mexico's Comisión Federal de Electricidad.[74] According to a release by Sierrita Gas Pipeline LLC, the additional capacity "assists Mexico to meet its environmental goals of converting existing fuel-oil-fired power generation plants to efficient, clean burning natural gas and provide natural gas to fuel future power plants."[75]

Kinder Morgan East Line

The Kinder Morgan East Line transports refined petroleum products from the Western Refining El Paso refinery (recently acquired by Tesoro Corp.) to Arizona via a 400-mile system consisting of two parallel lines. Refined products are transported to Tucson by a dedicated 12-inch pipe, while a 16-inch pipe passes through Tucson carrying product to the Phoenix market. Refined products are piped from El Paso to Tucson in seven days.

Refined products moving through the line include regular and premium gasoline, diesel fuel and jet fuel. The Kinder Morgan East Line currently provides refined petroleum products to meet 100 percent of southern Arizona's fuel demand and approximately 50

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[71] U.S. Energy Information Administration. Natural Gas Consumption by End Use. Arizona. 2017 https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SAZ_a.htm.

[72] Tucson Electric Power Press Release. "TEP to End Use of Coal, Switch Primarily to Natural Gas at Tucson Power Plant". 08/13/2015. https://www.tep.com/news/tep-to-end-use-of-coal-switch-primarily-to-natural-gas-at-tucson-power-plant/.

[73] U.S. Energy Information Administration. U.S. Natural Gas Pipeline Exports to Mexico. Accessed 08/2017. https://www.eia.gov/dnav/ng/hist/n9132mx2m.htm.

[74] Kinder Morgan. "Sierrita System Expansion, Additional Compression Planned" 01/2016. https://www.kindermorgan.com/pages/business/gas_pipelines/west/sierrita/default.aspx.

[75] Ibid.

percent of fuel demand for the Phoenix metropolitan region (the remaining 50 percent is supplied through the West Line, carrying refined products originating in southern California). The clear majority of the refined petroleum consumed in southern Arizona originates in the fields of West Texas.

Tucson Gas Terminals

All refined petroleum products flowing into Tucson arrive at the Kinder Morgan and Holly Energy terminals located at Dodge Boulevard and Ajo Way. According to a representative of Kinder Morgan, the terminals process approximately 3,500 barrels of refined petroleum each hour. Once the petroleum arrives in Tucson, it is moved into storage tanks, where it stays until it is loaded onto tanker trucks for delivery to the final customer. Primary customers include gasoline service stations, Tucson International Airport (jet fuel), mines and construction companies, which use refined petroleum products in asphalt mixes. Additionally, 23,000 barrels of jet fuel are transported directly into DMAFB weekly via a 6-inch lateral pipe.

Approximately 200 trucks per day are loaded with petroleum at the Tucson terminal. The proprietary additives that differentiate name brand gas retailers are added at the loading racks prior to final delivery.

Ethanol, which is mixed with gasoline to meet air quality requirements, is brought to the terminal by rail from the Midwest. Each week, 30 carloads are delivered directly into the terminal at an on-site railcar offloading.

Capacity

Though privately owned, the pipeline network is a critical component of the PAG region's freight network, as it supplies most of the area's energy resources. The pipelines help to keep the community running while keeping trucks off the road. If refined petroleum liquids were transported over the road from Texas, for example, there would be approximately one tanker truck every 18 seconds passing on I-10 for the entire distance between Tucson and El Paso.[76] Having direct access to the source also assists in keeping gas prices low in the community, as evidenced by the fact that the PAG region regularly has some of the lowest gas prices in the nation. Significant recoverable reserves of crude oil recently discovered in the "Wolfcamp shale" formation in West Texas will ensure that Tucson and Phoenix continue to have access to cheap and reliable liquid petroleum products for years to come.[77]

[76] Source: Interview with representative of Kinder Morgan.

[77] U.S. Geological Survey. "USGS Estimates 20 Billion Barrels of Oil in Texas' Wolfcamp Shale Formation". 11/2016. https://www.usgs.gov/news/usgs-estimates-20-billion-barrels-oil-texas-wolfcamp-shale-formation.

In 2006 and 2007, Kinder Morgan upgraded pipes and expanded capacity on the entire East Line. The East Line can now transport more than 200,000 barrels of petroleum per day. With the recent investments, no capacity upgrades likely will be needed within the foreseeable future.

Regional Freight Corridor Identification

Up to this point, this chapter has largely focused on describing the condition and performance of existing freight assets in the PAG region. The final section of this chapter changes focus somewhat to describe the purpose and approach for identifying a new component of the region's freight network, which PAG is calling Regional Freight Corridors (RFCs).

Background and Purpose

Freight vehicles travel over most of the region's roads to pick up or deliver goods within and across the region. However, because not all roadways are equally important in serving goods movement, the Freight Plan identifies specific corridors that are especially important for the movement of goods; these are known as RFCs. RFCs are the corridors upon which a high number of trucks travel daily, moving high-value freight from the point of production, bringing shipments to or from distribution centers and warehouses, or making deliveries. The intent of identifying regionally important freight corridors is to provide a useful planning tool that highlights the roadways that are most important in supporting the region's goods-based economy.

The seed of the RFC effort grew out of the Critical Urban Freight Corridor (CUFC) designation process that PAG led, in consultation with ADOT, as part of its MPO freight planning responsibilities. CUFC is a new corridor designation created under the 2015 FAST Act that helps states strategically direct resources toward improved system performance and efficient movement of freight. PAG submitted the region's recommendations to FHWA and received a letter of concurrence in May 2017.

CUFC designation has certain restrictions, which have excluded important freight corridors from formal designation. Firstly, CUFC mileage is capped on a formula basis at the state level, per FAST Act regulations. The State of Arizona is limited to 102 miles of designated CUFCs. Of that, 30 miles were allocated for the Tucson urban area through discussions with ADOT and Maricopa Association of Governments. The second limitation placed on CUFCs is that only roadways located within the urbanized area boundary (which excludes many rural and suburban areas of Pima County) are eligible for designation.

The limitation of 30 miles and restrictive geography proved to be inadequate to fully take account of those corridors important to freight in the region, which is why, with the guidance of the Freight Plan Task Force, PAG pursued creating an expanded RFC network. It is important to note that CUFC is a formal designation recognized by FHWA and ADOT, while the RFC is an informal regional identification used only for planning and regional decision making. CUFCs, which can be re-designated on a rolling basis, are included as part of the broader RFC network. More information about PAG's CUFC designation can be found in Appendix 5.

Uses of the RFC network will include:

- focusing freight analysis and priorities for the freight plan
- supporting transportation decision making through consideration in the Transportation Improvement Program (TIP) process
- guiding future truck count locations
- providing better understanding of traffic movement on the regional transportation network for future project identification

Additionally, in the future, RFCs could be used to:

- develop regional freight corridor design guidelines
- support pavement and bridge management efforts
- place new truck signage
- assist in re-designating CUFCs in the future

The following describes the eight-step process by which the RFC network was developed.

Regional Freight Corridor Identification Approach

PAG used jurisdictional and stakeholder input combined with a score-based GIS and travel-modeling approach for ranking potential roadways for RFC designation.

Steps 1-3 are included automatically as part of the RFC list.

1. Interstates

Interstates were automatically added to the RFC list as critical to both national and regional freight movement (though most of the value of the RFC process is in the identification of important non-interstate corridors).

2. Jurisdictional Identification

PAG conducted outreach to regional jurisdictions to identify important freight corridors. Corridors identified by the jurisdictions were automatically included in the RFC network, with minor revisions.

3. Critical Urban Freight Corridors

CUFCs were included in the RFC network because of their formal federal designation as important non-interstate freight corridors.

Steps 4-7 relied on a score-based approach to supplement input received from jurisdictions. Freight data from TRANSEARCH and ATRI were used in the evaluation and scoring of corridors.

4. Freight Volumes

Truck volumes were estimated on regional corridors using ATRI GPS route data collected over 16 weeks in 2016. Scores were assigned based on natural breaks in the numbers as determined by ArcMap GIS software. Routing of freight trucks was estimated using PAG's travel demand model using a shortest-distance algorithm.

16-week truck volume	Score
120,000+ total freight trucks	10
57,000–119,999	8
32,000–56,999	6
20,000–31,999	4
Fewer than 20,000	0
Data Source: PAG analysis of 2016 ATRI data	

5. High-Value Freight Generating TAZ

Since ATRI does not provide commodity data about trucks, the value of freight moving into and out of specific TAZs was estimated using TRANSEARCH source data. Corridors connecting high-value TAZs were identified by PAG using TRANSEARCH data cross-checked against other sources, such as ATRI, as a way of prioritizing corridors serving high-value commodity flows in the region.

High-value TAZ connection	Score
Corridor connecting high-value TAZ	8
Not identified	0
Data Source: PAG analysis of TRANSEARCH	

6. Stakeholder Identified Routes

Stakeholder routes were routes identified by the Freight Plan Task Force at the August 2016 freight plan kick-off meeting as part of the initial CUFC designation effort. Three small groups worked independently of each other to indicate corridors seen to be most important to the movement of goods. These were incorporated into the RFC analysis to reflect Freight Plan Task Force priorities. Scores were based on the number of tables that independently identified a specific segment.

Tables identifying segment	Score
Identified at three tables	8
Identified at two tables	6
Identified at one table	4
Not identified at any tables by stakeholders	0

7. Connects an Intermodal Freight Facility to Another Intermodal Freight Facility or an Interstate

Corridors connecting the Port of Tucson to Tucson International Airport or that connect either intermodal facility to the interstate were assigned 10 points.

Intermodal connection	Score
Connects a freight intermodal facility to the interstate or another freight intermodal facility	10
Does not connect an intermodal facility to the interstate or another intermodal facility	0
Data Source: Intermodal identification, GIS files identifying connections	

8. Final RFC Network Determination

The scoring approach described in steps 4 through 7 helped to narrow and focus the number of potential corridor segments but did not provide a final network. A draft proposed RFC network was established by PAG using the following:

- Unrouted GPS segment density from the ATRI dataset (instead of routed truck volumes, which introduces bias into the process based on the shortest distance route assignment approach)

- ATRI truck trip ends concentrations (showing major freight truck origins and destinations)
- Regional freight-intensive employer locations
- Freight routing estimates from specific, regionally important freight generators
- Stakeholder interviews
- Connections to close minor network gaps

The draft network was presented to the Freight Plan Task Force for review before the final network was determined. **Figure 3.23** shows the final RFC network, totaling just over 285 centerline miles of roadways.

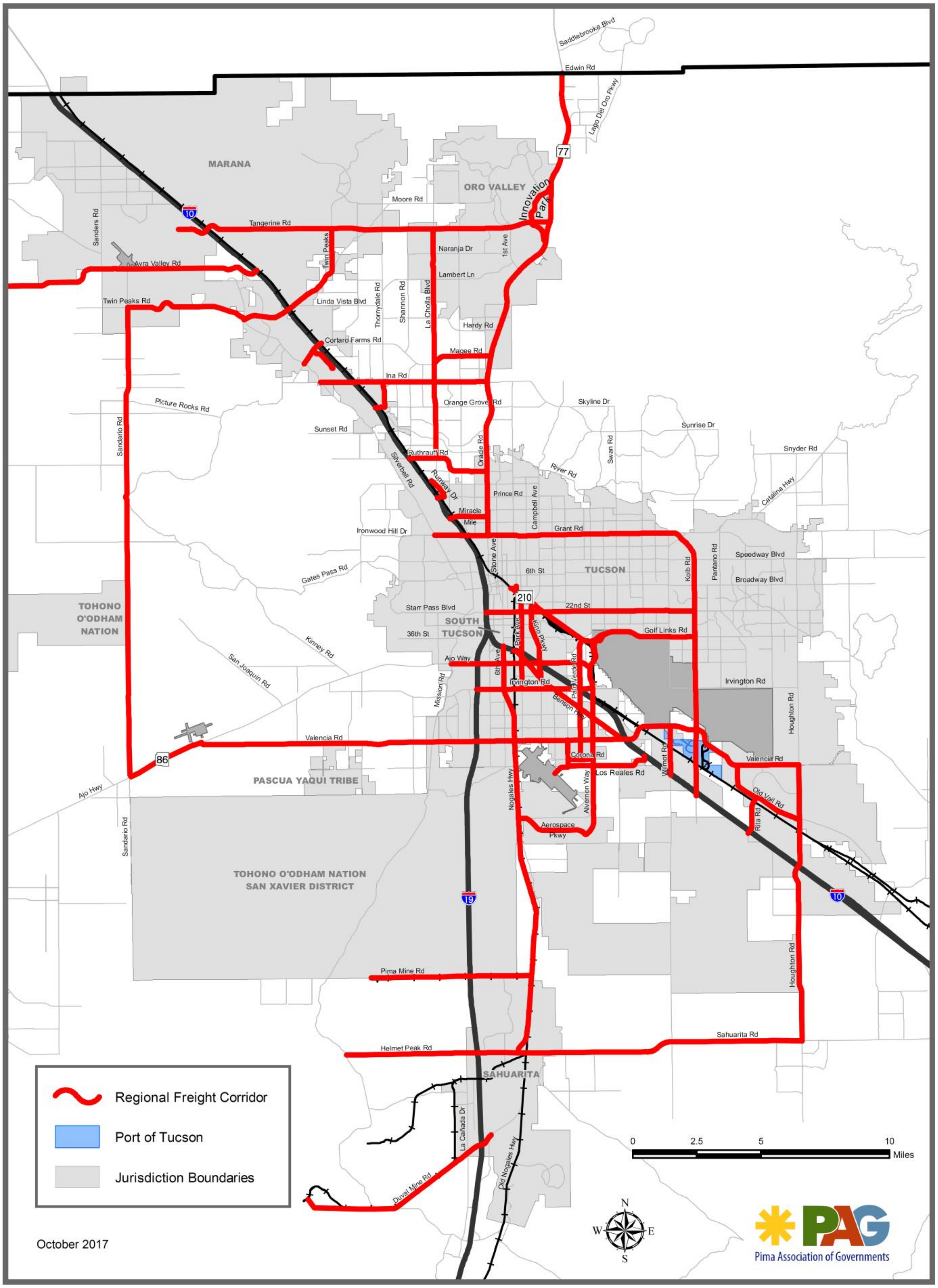
For a discussion of freight performance on the RFC network, see **Appendix 2** of the Freight Plan.

Summary

The PAG region is home to many freight assets, including a portion of a critical cross-country interstate, a Class I railroad, a truck-to-rail intermodal facility, an international airport, and interstate gas and liquid pipelines. This collection of freight assets provides a strong foundation for attracting and expanding export-generating businesses, and the transportation and logistics industry.

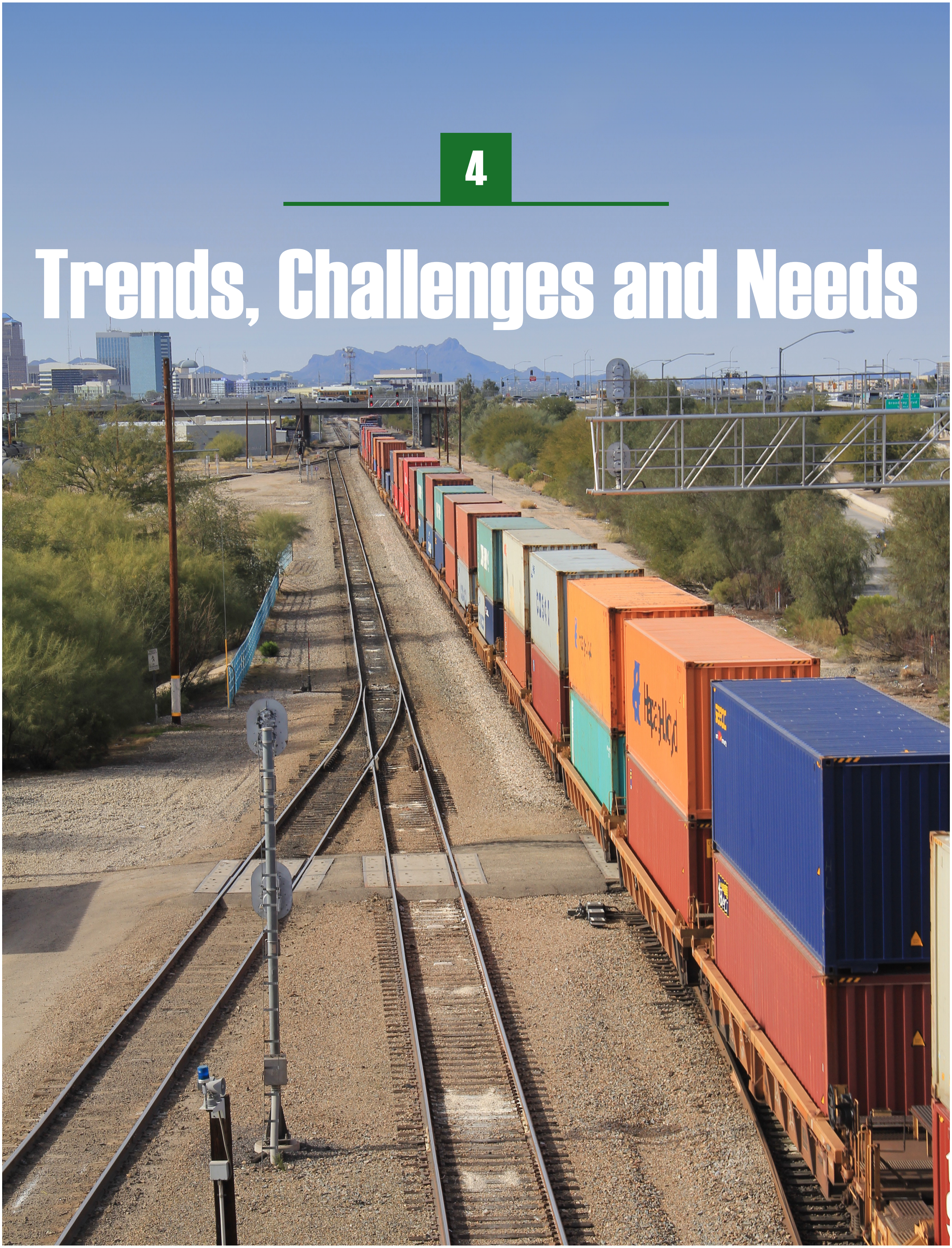
A commitment to investing in the region's freight transportation infrastructure is essential for continued economic success. The designated RFCs may help determine where corridor investments should be made to have the biggest economic impact. The next chapter looks in more detail at needs, challenges and opportunities on the freight transportation network.

Figure 3.23 Regional Freight Corridor network



4

Trends, Challenges and Needs



4. Trends, Challenges and Needs

Chapter 3 provided an overview of how well the various freight facilities within Pima County serve the movement of goods. **Chapter 4** identifies freight-specific needs, challenges and opportunities on the transportation system.

Overview

In the coming years, with the continuing growth in online shopping and the expansion of international trade and globally dispersed supply chains, freight volume is expected to increase significantly in all modes. Combined with growth in passenger vehicle travel, future freight demand will intensify competition for limited roadway capacity and present other infrastructure challenges, particularly in the fastest-growing urban areas with the highest demand for delivery of goods. Evolving technologies may allow for more efficient use of infrastructure and offset demand, but also may require costly upgrades to signal and communication technology.

To keep pace with emerging demand, the region can look at trends affecting freight movement and consider employing regulatory, operational and infrastructural modifications to strengthen the PAG region's position, and supporting economic growth.

Trends in Freight Movement

Between 1990 and 2015, total national freight ton miles by all modes increased by 38 percent, growing at a rate faster than the U.S. population. Truck ton miles, in particular, increased more than 76 percent over the period, capturing an ever-larger modal share of U.S. goods movement.[78] In the next 25 years, USDOT predicts that truck freight tonnage will increase by 43 percent nationally,[79] with truck VMT growing nearly twice as fast as that of passenger vehicles.[80]

In Pima County, PAG's 2045 RMAP estimates that total vehicle travel will increase by approximately 50 percent by 2045. This is primarily owing to expected growth in population—and the commensurate increase in commercial activity stemming from a larger population—leading to increased regional travel demand. The travel forecast is not necessarily sophisticated enough to adequately account for global economic patterns and, therefore, may not be sensitive to increasing truck travel generated from

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[78] U.S. Department of Transportation. Federal Highway Administration. 2016 Freight Quick Facts Report. https://ops.fhwa.dot.gov/publications/fhwahop16083/fhwahop16083.pdf.

[79] U.S. Department of Transportation. Beyond Traffic 2045: Trends and Choices. https://www.transportation.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf.

[80] U.S. Department of Transportation. Federal Highway Administration. Office of Highway Policy Information. FHWA Forecasts of Vehicle Miles Traveled (VMT): Spring 2017. https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.cfm.

California ports, Mexico, or other domestic markets that may be passing through southern Arizona.

In terms of a broader economic outlook, the 2016 HSBC Global Connections Trade Forecast report for the United States predicts that both imports and exports will grow at an average annual rate of around 5 percent until 2030.[81] The same report projects that China and Mexico will continue to be two of the nation's top five trading partners during that timeframe, indicating that trade flows should remain consistent with current patterns.[82] Interstate 19 and I-10, as major trade gateway corridors for two of the nation's largest trading partners, will likely see growth in truck traffic carrying goods to and from Mexico and the Ports of Los Angeles/Long Beach (as well as rail traffic on the Union Pacific Sunset Route).

Increased national goods movement (particularly by truck), intensification of trade, and local population and commercial growth will put more trucks and cars on the region's interstates and other freight corridors. In fact, the Freight Analysis Framework from FHWA and the Bureau of Transportation Statistics projects that long-haul truck volumes on I-10 and I-19 through the PAG region will roughly double by 2045.[83] At the same time, growth in freight rail tonnage will result in more train cars on the Sunset Route, adding delay for the traveling public and safety conflicts at railroad grade crossings.

While it is difficult to predict with certainty, several potential developments and emerging trends also may begin to impact how and where freight moves in the region. Among these are potential shifts toward regionalization, the widening of the Panama Canal, continuing growth of e-commerce, and evolving vehicle technologies. It is yet unknown to what extent any one of these factors will affect goods movement in the PAG region.

Regionalization

One particularly interesting development noted in the HSBC report is the "potential shift toward regionalization of cross-border supply chains as U.S. firms re-appraise their production strategies." This shift will allow Mexico to strengthen its position as a supplier of goods to the U.S. market as the "rate of increase in Chinese import penetration slows." In the long run, the shift to regionalization and the growth of Mexico as a supplier could present an increasing number of supply chain opportunities in southern Arizona, particularly in aerospace and other areas of advanced manufacturing where strong commercial connections already exist.

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[81] HSBC. United States Trade Report. 12/2016 https://globalconnections.hsbc.com/downloads/trade_forecasts/us.pdf

[82] Note: At the time of the writing of this Freight Plan, NAFTA terms were being renegotiated. The outcomes of those renegotiations could potentially have a major impact on North American trade patterns.

[83] U.S. Department of Transportation. Federal Highway Administration. HEPGIS. Accessed 09/2017. http://hepgis.fhwa.dot.gov/fhwagis/ViewMap.aspx?map=Freight+Analysis|2012+FAF4+Long+Distance+Truck+Network+Flow.

If this shift to regionalization occurs in any significant way, I-19 will become more important as a regional and national commercial corridor. To fully capitalize on this opportunity, connections to the Mariposa BPOE in Nogales, Arizona, will need to be upgraded. To address the need, ADOT is currently studying corridor improvements to SR 189, which connects I-19 to the Mariposa BPOE. It is anticipated that construction on corridor improvements will begin in 2019.[84]

Panama Canal Widening

In the summer of 2016, the largest-ever expansion of the Panama Canal, since its opening in 1914, was completed. The $5 billion project doubles the cargo capacity of the canal and, most importantly, allows significantly larger vessels to traverse the waterway. Prior to expansion, the canal could accommodate only ships with a capacity of up to 5,000-TEUs (TEU stands for 20-foot equivalent units, the size of a standard container, which is used as a measure of ship capacity) but can now handle ships with a capacity of 13,000-14,000 TEU. This expansion permits the larger container ships originating in Asia, which would previously only call at West Coast ports due to the inability to travel through the canal, to travel directly to ports on the Gulf Coast and Eastern Seaboard. With nearly 60 percent of the U.S. population residing east of the Mississippi River, this change allows large cargo ships to unload closer to consumers, thereby lowering shipping costs through reduced overland travel distances. However, maritime shipments to the East Coast will take 10 days to two weeks longer than intermodal shipments from the West Coast, so more time-sensitive freight from Asia will still likely travel overland from west to east.[85]

Upgrades at East Coast ports are underway to prepare for these larger vessels. For example, the Port Authority of New York and New Jersey recently completed the main part of the Bayonne Bridge Navigational Clearance Project, enabling 14,000-TEU ships to access all the Port of New York-New Jersey's container terminals. A year after the completion of the Panama Canal widening project, early indications show that some Asian imports have begun to shift to East and Gulf Coast ports. In the first four months of 2017, the share of Asian imports processed at East Coast and Gulf Coast ports increased by about 1.5 percent over the previous year, while the share of Asian imports moving through West Coast ports decreased by a similar amount. That said, 65 percent of Asian imports still enter the United States through the West Coast.[86]

For southern Arizona, increased access to the East Coast and Gulf of Mexico for Asian imports may slow the growth in the through-movement of goods traveling from Los

[84] ADOT. State Route 189 Study: International Border to Grand Avenue. https://www.azdot.gov/planning/transportation-studies/sr-189-study-international-border-to-grand-avenue/overview

[85] Mongelluzzo, Bill. "Asian imports drift to US East, Gulf coasts". *Journal of Commerce*. 05/17/2017. http://www.joc.com/port-news/us-ports/asian-imports-drift-us-east-gulf-coasts_20170517.html

[86] Ibid.

Angeles to the southeastern United States, at least insofar as a significant portion of goods passing through from Los Angeles originate at the ports.

E-commerce

Over the last decade, online shopping has captured an ever-larger share of retail sales. Between 2007 and the first quarter of 2017, e-commerce grew from just under 3.5 percent of total retail sales to 8.5 percent.[87] If current trends continue, some estimate that e-commerce may account for 20 percent of all retail sales (excluding gasoline sales) nationally by 2035.[88] Concurrent with this growth has been an increasing customer expectation for online retailers to offer two-day, next-day and, in some markets, same-day delivery, introducing far more risk and complexity for logistics managers.

To meet customer expectations, retailers have been rapidly expanding warehousing and distribution capacity near population centers to shrink the distance to customers. These are often purpose-built facilities of hundreds of thousands of square feet that employ hundreds of workers. Finding appropriate locations in the largest urban areas can be difficult due to the amount of land required for the structure, the truck loading bays, employee parking and the need to have reliable freeway access. With considerable available land, relatively low costs, a large labor force and consumer base, as well as access to some major markets in the Southwest, the PAG region could be well-positioned to see expansion in the warehousing and distribution sector.

Delivery services also have surged as more small parcels are going directly to homes instead businesses. This shift is complicating last-mile deliveries and putting more vehicles on the road as home-based delivery is not nearly as efficient, from a carrier perspective, as traditional business delivery.

The increase in home-based parcel delivery and shipments to and from a more widely distributed network of warehouses and fulfillment centers may put further strain on transportation infrastructure, particularly in the most densely populated urban areas, where road capacity is already limited. In the PAG region, the growth in e-commerce presents an additional challenge in that it reduces sales-tax revenue, a major fund source for local governments and regional transportation improvements. Additional revenue sources and funding mechanisms will need to be explored to keep pace with the anticipated demands placed on the transportation system.

[87] U.S Department of Commerce. U.S Census Bureau News. Quarterly Retail E-commerce Sales 2nd Quarter 2017. 08/17/2017. https://www.census.gov/retail/mrts/www/data/pdf/ec_current.pdf.

[88] Hoover, Gary. "The Future of Ecommerce vs. Brick & Mortar Retailing". LinkedIn. 07/13/2016. https://www.linkedin.com/pulse/future-ecommerce-vs-bricks-mortar-retailing-gary-hoover.

Autonomous Trucks and Platooning

Autonomous Trucking

Innovations in autonomous and vehicle communication technology have the potential to improve the safety and efficiency of freight movement while reducing vehicle emissions and traffic congestion. The trucking industry already uses some degree of automation (e.g., adaptive cruise control and automatic emergency-braking),[89] and several companies have reached the testing phase in developing fully autonomous trucks for transporting freight.[90] Regulatory barriers, public acceptance and issues of liability, however, suggest widespread adoption of fully autonomous trucks remains years away.[91]

Trucks operate autonomously through a combination of short-range radar, long-range radar, and/or LIDAR (Light Detection and Ranging) and a video camera system.[92] Future autonomous vehicles also may use vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies. In 1999, the Federal Communications Commission designated the 5.9 Dedicated Short-Range Communications (5.9 DSRC) range to incorporate V2V and V2I technologies into intelligent transportation systems.[93] This technology allows for rapid data transmission rates, although with a limited range.

Platooning

Platooning is an application of autonomous trucking technology that uses radar/LIDAR combined with V2V technology to allow for close following distances between two or more trucks. Platooning, initially, will be limited to two vehicles and require all drivers to actively steer their vehicle. Radar and V2V technology, however, will allow for coordinated and autonomous braking and acceleration, permitting vehicles to maintain a closer following distance.[94] Trucks could begin using this technology on U.S. highways within the next year.[95] Future iterations of platooning technology will involve additional trucks that follow with lateral (i.e., steering) and longitudinal (i.e., acceleration and braking) autonomous control, allowing trucks that follow to operate without a driver. Introduction of fully automated platooning is expected in the 2020 to 2022 timeframe.[96]

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89 American Trucking Association Technology and Maintenance Council, Future Truck Program, Automated Driving and Platooning Task Force. (2015, Sept. 21) White Paper: Automated Driving and Platooning Issues and Opportunities.

90 Short, J., and Murray, D. (2016). Identifying Autonomous Vehicle Technology Impacts on the Trucking Industry.

91 Morgan, C., et al. (2017). Assessment of Innovative and Automated Freight Strategies and Technologies-Phase I (No. FHWA/TX-17/0-6837-1).

92 Short and Murray, 2016.

93 Short and Murray, 2016; Federal Communications Commission. FCC Allocates Spectrum in 5.9 GHz Range for Intelligent Transportation Systems Uses. [Press release]. October 21, 1999. https://transition.fcc.gov/Bureaus/Engineering_Technology/News_Releases/1999/nret9006.html.

94 Id.

95 ATA, 2015.

96 Id.

The reduced following distance that platooning allows has multiple benefits to industry and the public, including better use of assets, improved fuel efficiency, reduced emissions and reduced traffic congestion.[97] Researchers predict a 4.5 percent to 8 percent improvement in fuel efficiency for the leading truck and a 10 percent to 16 percent improvement in fuel efficiency for trailing trucks in a platoon.[98] Considering that nearly 90 percent of truck crashes are attributable to human error,[99] increased automation also may result in a significant safety benefit to the public.

The successful implementation of platooning technologies will likely face regulatory barriers, however, especially with regard to safe following distance regulations. Jurisdictions also may need to redesign some regional infrastructure, such as roundabouts, bridges, and on and off ramps to accommodate platoons. [100] For a fuller discussion of emerging technology in freight, see **Appendix 4** of the Freight Plan.

Freight Impacts

While overall freight traffic will most likely increase, the nature of how and where that freight moves may change. In the face of freight growth and the potential for changing patterns, the next section discusses freight transportation needs in the PAG region. These are organized into regulatory challenges, operations and maintenance needs, and freight capacity issues. The issues and challenges were identified through meetings with more than 20 private freight stakeholders over the course of 2017 (**Figure 4.1**), discussions with PAG regional jurisdictions, input from the Freight Flan Task Force and analysis of freight data.

Needs and Challenges

Regulatory Challenges

Electronic Logging Devices and Truck Parking

In December 2015, the Federal Motor Carrier Safety Administration (FMCSA) published a rule for commercial vehicle drivers that will require the use of electronic logging devices (ELDs) in their vehicles. The rule fulfills a statutory requirement of the Moving Ahead for Progress in the 21st Century Act (MAP-21), which was enacted by Congress in July 2012.

[97] Short and Murray, 2016.
[98] Ibid.
[99] U.S. Federal Motor Safety Administration. (2007) Large-Truck Crash Causation Study – Weighted data.
[100] Short and Murray, 2016.

Figure 4.1 Regional Freight Plan interview participants

The ELDs are used as electronic logbooks, which replace the paper logbooks some drivers currently use to record their compliance with the federal hours of service (HOS) requirements. An ELD works by continuously monitoring a vehicle's engine to capture data on whether the engine is running, whether the vehicle is moving, miles driven and duration of engine operation (engine hours). With an ELD, law enforcement can review a driver's hours of service by viewing the ELD's display screen, by a printout from the ELD and, in the near future, by retrieving data electronically from the ELD.

The FMCSA estimates the ELD rule will impact approximately 3.4 million drivers. Motor carriers and drivers subject to the ELD rule were required to start using ELDs by the compliance date of Dec. 18, 2017. Those already equipped with electronic logging technology will have until December 2019 to ensure compliance with the published specifications.

While government regulators and the American Trucking Association support the mandate, many carriers have expressed serious concerns about costs, privacy and difficulty finding truck-appropriate parking.[101] According to the American Transportation Research Institute's (ATRI) annual industry survey, *Critical Issues in the Trucking*

[101] Dills, Todd. "ELD mandate: Independents' final straw?" Online. http://www.overdriveonline.com/tag/eld-survey/.

Industry, truck parking was ranked as the third most important industry issue in 2016.[102] Currently, drivers are able to drive past their HOS in order to find appropriate parking. Driver logbooks record HOS in 15-minute increments resulting in a "buffer" for drivers, whereas ELDs record up to the minute.

In recent years, several national and regional truck parking studies have documented the growing truck parking problem. For example, a 2016 Kansas DOT-administered survey of more than 1,300 truck drivers found that a majority of drivers spend at least 30 minutes on average searching for parking each day. Almost half (47 percent) reported search times of 30 minutes to an hour, and almost one-third reported search times of more than an hour (31 percent).[103] These numbers are consistent with other studies from around the country. If a driver cannot find a legal parking space when the HOS runs out, he or she is in a precarious position: The driver must choose between violating HOS rules and incurring a fine, or parking illegally, possibly in locations where trucks are not designed to be parked. This predicament presents a safety issue not only for the driver but also for the public. Due to the already demonstrated lack of adequate truck parking, the ELD mandate may exacerbate the issue by causing overcrowding at existing rest areas and truck stops and by causing an increase in unauthorized parking, such as on shoulders and interstate entrance ramps. Furthermore, the mandate will require greater planning on the part of drivers and increased communication among drivers, dispatchers and parking providers, to ensure drivers are able to locate safe parking and still abide by the HOS regulations.

Despite potential concerns, the expanded use of ELDs does provide an opportunity to collect, pool and disseminate data about truck parking needs, locations, trends, time-of-day peaking characteristics, etc. This data could provide the trucking industry and government agencies with data to support efforts to identify locations on an ongoing basis where parking demand exceeds existing supply.

In Arizona, efforts are currently underway to find solutions to potential truck parking issues that may arise. For example, ADOT is re-opening previously closed rest stops to accommodate the newfound need. PAG will work with state and local officials to examine regional truck parking issues. This may include integrating truck parking into the transportation planning process and facilitating discussion of local-level needs and benefits.

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[102] Boris, Caroline and Rebecca Brewster. "Managing Critical Truck Parking Case Study – Real World Insights from Truck Parking Diaries." American Transportation Research Institute. Online. http://atri-online.org/wp-content/uploads/2016/12/ATRI-Truck-Parking-Case-Study-Insights-12-2016.pdf.

[103] Shirk, Alexandra and Dan Murray. "Kansas Truck Parking Survey Analysis." Kansas Department of Transportation. Online.https://www.ksdot.org/Assets/wwwksdotorg/bureaus/burRail/Rail/Documents/Kansas_Statewide_Freight_Network_Truck_Parking_Plan_2015_2016.pdf.

Coordinating Oversize and Overweight Regulations

In March 2017, Arizona Governor Doug Ducey signed into effect Arizona House Bill 2371: Oversize Commercial Vehicles; Local Authority (HB2371), which requires jurisdictions that issue oversize/overweight (OS/OW) permits to adopt and enforce ordinances substantially identical to rules adopted by ADOT relating to OS/OW commercial vehicles. The bill also allows for those same jurisdictions to adopt ordinances relating to infrastructure restrictions, route restrictions and time-of-day restrictions.

Jurisdictions in Pima County are reviewing the bill's requirements and working with ADOT and their governing bodies to become compliant. The purpose of the bill is to allay industry concerns over the consistency of OS/OW regulations across the state. Proponents argue that HB2371 will make regulations more consistent and permits easier to obtain, thereby leveling the playing field among those who comply with OS/OW regulations and those who ignore them. Coordination between owning agencies of local infrastructure and ADOT will establish a common understanding of the rules to help increase compliance with the law.

HB 2371 also potentially lays the foundation for a future statewide permitting system, so carriers would have a single point of contact and a single permit issued for a designated route. In doing so, Arizona could become more freight-friendly and attract additional freight commerce.

Funding

Finding adequate funding for transportation is a perennial challenge, made more acute by a confluence of factors: Federal and state gas taxes have not increased since the early 1990s and now have considerably reduced purchasing power due to increased construction costs (the per-gallon tax rate does not change with inflation). Motor vehicles are becoming more fuel-efficient, reducing fuel consumed, and thus reducing taxes paid per mile driven. Finally, the growth in online shopping has begun to erode sales tax revenues and will likely have a greater impact in the future.

The region will need to continue to look at funding options to keep pace with increased traffic, especially if heavy trucks and delivery vehicles are to become a greater share of vehicles on the road.

Operations and maintenance

Roadway Condition

The condition of the region's roadways continues to be a concern for the traveling public and freight carriers alike, though the region's jurisdictions have made considerable progress in recent years addressing needed repairs. Between 2011 and 2016, the share of major roadways classified in poor condition decreased from 53 percent to 37 percent. Looking ahead, the region will need to continue its commitment and identify sustainable funding for fixing roads and preserving them once repaired.

Bridges

As with roadways, bridges need to be maintained and periodically repaired and replaced to remain functional. Currently, the region has an estimated 16 weight-restricted bridges; two of these are located on identified RFCs. On corridors where no nearby viable route alternatives exist, weight restrictions can lead to costly delays and confusion for heavy-vehicle operators and shippers. Fortunately, both weight-restricted bridges located on RFCs—22nd Street and South Houghton Road—are planned to be replaced under the RTA plan. Another weight-restricted bridge on an RFC (Pima Mine Road) was recently replaced with the assistance of RTA funds.

Because it is not always possible to replace bridges as quickly as would be ideal, where weight restrictions exist, signage indicating those restrictions needs to be posted in locations that allow for adequate time to re-route. In instances where this involves multiple owning agencies, coordination needs to occur to ensure consistency and that adequate information is provided to heavy-vehicle operators.

Traffic Signal Maintenance and Upgrades

Given the dominance of the arterial network in regional traffic movement, it is vital that traffic signals are maintained, timed appropriately and coordinated. Ineffective maintenance of the signal network leads to unnecessary delay and frustration for travelers and can make freight deliveries more unreliable. According to USDOT's Congestion Reduction Toolbox, improper traffic signal timing accounts for 5 percent to 10 percent of all traffic delay nationally.

At the time of the Freight Plan's writing, three out of four traffic signals in the PAG region are operated by 35-year-old computers, and over half of regional traffic signal equipment (signal heads, controllers, detectors, communications and more) needs replacement. As equipment ages, it is more likely that signals will drift from timing plans and experience breakdowns in communication with other parts of the network. The resulting poorly coordinated and mistimed signals reduce the operating efficiency of the region's roadways and add unnecessary driver and commercial vehicle delay.

Looking ahead, an aged signal network means the region will be unprepared to benefit from emerging innovations in the areas of traffic operations — innovations which are projected to have a profound impact on road network performance. For example, a pilot deployment in Pittsburgh of smart traffic signals resulted in reductions of 40 percent in vehicle wait time, 26 percent in travel time and an estimated 21 percent in vehicle emissions.[104] Improvements of that magnitude would go a considerable way in meeting multiple regional transportation goals. Preparing for "smart" functionality requires that the region bring the traffic signal network and supporting communication system into a state-of-the-art condition; failing to do so will limit the ability to deploy this technology in any meaningful way. A starting point may be to identify critical corridors to pilot the technology and expand from there.

Freight Capacity

Railroad Grade Separation

The region currently has approximately 76 at-grade rail crossings, 18 of which are on major roadways. If rail freight volumes increase out of Los Angeles and across the border, the number and length of trains traveling through the region can be expected to grow, leading to ever greater disruptions to traffic flow on the region's corridors. A few railroad grade-separation projects, addressing some of the biggest problem areas, are currently in the region's construction program or long-range plan, including at Ina Road (currently under construction), 6th Street (under construction), Ruthrauff Road, 22nd Street and Cortaro Farms Road. However, given the number of remaining grade crossings, it may be advisable to conduct a study to determine the extent of the need and prioritize future separation projects.

Tables 4.1 and 4.2 show the 18 locations of at-grade crossings on major roadways. The tables also include total estimated vehicles and trains that move through the crossing each day as a way of demonstrating likely traveler delay and exposure.

Table 4.1 Major at-grade rail crossings on the UPRR Sunset Route (2016)

Union Pacific Sunset Route Mainline — 40 to 50 trains per day			
Street name	**Nearby cross street**	**Vehicles per day** (nearest traffic count)	**Crossing status**
Tangerine Road	I-10	6,000	In 2045 RMAP reserve project list
Cortaro Farms Road	I-10	21,000	In long-range plan (2045 RMAP)
Ina Road	I-10	27,000	Under construction
Ruthrauff Road	I-10	27,000	Programmed for construction in 2019
N. Granada Avenue/ Main Avenue	University Boulevard	8,000	No planned improvements

[104] "Smart Traffic Signals". Carnegie Mellon University. 2012. https://www.cmu.edu/homepage/computing/2012/fall/smart-traffic-signals.shtml.

Union Pacific Sunset Route Mainline — 40 to 50 trains per day			
Street name	**Nearby cross street**	**Vehicles per day** (nearest traffic count)	**Crossing status**
6th Street/9th Avenue	Stone Avenue	20,000	RR grade separation in 2018 as part of Downtown Links project
Ajo Way	Alvernon Way	21,000 (count location on other side of major intersection and may not reflect volumes at the crossing)	No project identified
Irvington Road	Alvernon Way	17,000 (count location on other side of major intersection and may not reflect volumes at the crossing)	No project identified
Rita Road	Old Vail Road	15,000	No project identified
Colossal Cave Road	Mary Ann Cleveland Way	11,000	No project identified

Table 4.2 Major at-grade rail crossings on the UPRR Nogales Subdivision

Union Pacific Nogales Subdivision — 6 to 8 trains per day			
Street name	**Nearby cross street**	**Vehicles per day** (nearest traffic count)	**Crossing status**
22nd Street	6th Avenue	28,000	Programmed for construction in 2020 as part of 22nd Street widening project
Ajo Way	6th Avenue	22,000	No project identified
Irvington Road	S. Nogales Highway	26,000	No project identified
Drexel Road	S. Nogales Highway	9,500	No project identified
Valencia Road	S. Nogales Highway	40,000	No project identified
Hughes Access Road	S. Nogales Highway	7,500	No project identified
Sahuarita Road	S Nogales Highway	7,500	No project identified
White House Canyon Road/Madera Canyon Road	S. Campbell Avenue	3,200	No project identified

Traffic Interchanges

In addition to bridges, several traffic interchanges on the region's interstates are dated and in need of replacement to meet current standards to better serve heavy vehicles. Twelve interchange projects are currently planned in the region as indicated in PAG's long-range transportation plan (2045 RMAP). Most of these projects will be undertaken as part of the widening of the I-10 and I-19 mainlines, including at Sunset Road, Orange Grove Road, Park Avenue, Country Club Road, Kolb Road and others. However, just because a project is planned, that does not mean the funding for it necessarily will be available in the future. It will be important to continue to work with ADOT and the region's jurisdictions to ensure that the region's interstate improvements remain a priority for the state.

Needed interchange improvements also exist beyond those that are planned, though no reasonably expected funding has been identified to pursue the projects. This includes interchanges at Tangerine Road, Avra Valley Road, El Toro Road, Wilmot Road, Rita Road and others. These projects can be included in transportation plans when funding is identified.

Network Density

A long-term need for the region is ensuring that corridor alternatives are available for the movement of goods and people. Limited roadway redundancy on the edges of the community guarantees that traffic is routed onto a few corridors, thereby increasing congestion and delay, especially in instances of accidents, construction, weather or other disruptions.

A need was identified by member jurisdictions during the freight planning process to look at increasing road network density on the northwest side of the region as well as to the south. In particular, a desire is to provide better east-west connectivity south of Tucson International Airport and east of Sahuarita, as well as exploring viable corridor alternatives to Tangerine Road and Oracle Road in the north, possibly into Pinal County.

5

Recommendations

5. Recommendations

The previous chapter provides an overview of broader global trends that may affect freight movement in the PAG region and outlines regional freight system challenges, needs and opportunities identified through stakeholder interviews and data analysis. This chapter outlines recommended goals, strategies and actions and recommended projects that can address the identified system challenges, needs and opportunities.

Overview

An analysis of regional freight data and transportation performance, as well as interviews with major users of the freight transportation system, indicates that the system is currently meeting most freight needs. However, new freight regulations, aging infrastructure and an expected increase in freight traffic mean that the region will need to continue to invest in the system to compete for freight activity. Additionally, capturing supply chain opportunities, due to regionalization, and expanding the advanced manufacturing sector will require ongoing promotion of the region's advantages as well as investments in new infrastructure that supports targeted economic growth zones (such as the Aerospace Research Campus).

To help the region meet its freight transportation goals, the Freight Plan identifies freight-specific strategies, actions and recommended projects to be pursued over the coming years. Importantly, many transportation improvements with a significant freight benefit, such as on I-10 and I-19, are already planned for the region. Therefore, the role of the Freight Plan is to identify which projects will align with regional freight strategies to support economic vitality rather than identify new projects. This approach will ensure that freight needs continue to be a major consideration in future funding discussions and prioritization.

Goals, Strategies and Actions

The following goals, strategies and actions were developed largely through interviews with freight stakeholders and member jurisdictions. Goals, strategies, and actions address project types and programmatic recommendations for improving the region's freight transportation system. The purpose is to establish actions that can be undertaken by PAG in the coming years as well as provide recommendations about the region's infrastructure and freight-supportive efforts to the owning agencies. Actions are not binding in any way on the owning agencies but are intended to support their efforts through reference in the Freight Plan and, thus, regional identification. Items are listed in no particular order:

Goal 1: A safe and reliable multimodal freight system with the capacity to meet current and future demand			
Strategies	**Actions**	**Potential lead agency/agencies**	**Purpose**
1.1 Improve the condition of the existing freight system infrastructure.	Continue to invest in pavement preservation and maintenance on Regional Freight Corridors (RFCs).	Owning agencies[105]	• Reduces wear on freight vehicles • Protects sensitive products
	Replace or repair functionally obsolete and deficient bridges on RFCs.	Owning agencies	• Eliminates need to re-route vehicles
1.2 Enhance traffic operations to support the movement of goods on regional corridors.	Establish a network of RFCs to designate where freight movements are expected and planned to occur.	PAG in consultation with owning agency	• Helps in planning and evaluating how the region is meeting the needs of freight
	Explore signal timing improvements and freight vehicle prioritization on RFCs.	Owning agencies with support from PAG	• Improves traffic flow of non-interstate corridors
	Maintain street trees, particularly in monsoon season, on RFCs.	Owning agencies	• Reduces damage to large vehicles • Improves sight lines for safety
	Track truck-involved crashes in order to identify current or emerging safety issues.	ADOT and PAG	• Enables the region to respond to freight safety issues

[105] Owning agency refers to the public entity that owns and operates the region's freight transportation infrastructure. These include ADOT, incorporated cities and towns, unincorporated Pima County, the Pascua Yaqui Tribe and the Tohono O'odham Nation.

Goal 1: A safe and reliable multimodal freight system with the capacity to meet current and future demand

Strategies	Actions	Potential lead agency/agencies	Purpose
1.3 Add roadway capacity, as needed, to keep pace with future freight demand and to respond to changing needs.	Continue regional commitment to delivering planned RTA projects.	Owning agencies with support from PAG/RTA	• Provides capacity and safety improvements on the region's transportation system
	Conduct an analysis of at-grade railroad crossings to determine grade-separation priorities.	PAG	• Identifies the most critical grade separations to pursue
	Add roadway network density where appropriate in order to provide alternative travel options and route redundancy.	Owning agencies with planning support from PAG	• Reduces congestion on existing corridors • Provides alternative routes in case of disruption
	Monitor congestion and reliability on RFCs to inform future investment decisions.	PAG	• Supports informed decision making about emerging capacity needs
	Expand regional truck count program.	PAG	• Identifies high-volume truck corridors and changing travel patterns
	Revisit RFC designation every 3 to 5 years.	PAG	• Ensures RFC network continues to reflect evolving freight patterns
1.4 Explore new and sustainable sources of funding for freight-	Encourage public-private partnerships to identify and implement improvements to the freight system.	PAG	• Provides a potential source of funding for projects that support good movement

Goal 1: A safe and reliable multimodal freight system with the capacity to meet current and future demand

Strategies	Actions	Potential lead agency/agencies	Purpose
related services and infrastructure.	Pursue federal funding opportunities for regional freight improvements, such as those created under the FAST Act.	Owning agencies and PAG	• Brings additional transportation funding to the community
1.5 Prepare the region to accommodate the arrival of new freight transportation technologies, such as connected and autonomous vehicles.	Upgrade communication technology on traffic signals to improve signal coordination and prepare for vehicle to infrastructure connectivity.	Owning agencies with support from PAG	• Allows signals to better communicate with each other to ensure synchronization • As the need evolves, may allow signals to communicate with vehicles to make them more responsive to real-time travel conditions
	Work with appropriate private entities and University of Arizona researchers to stay current with and open to transportation innovations	PAG	• Allows practitioners to stay current with latest developments • Positions the region to be a leader in transportation innovation
	Identify corridors to pilot the implementation of new transportation technologies	PAG	• Prepares the region to test technologies as they become available
1.6 Minimize the impacts of over-legal truck loads on local infrastructure and traffic operations.	Increase coordination of overweight and overdimensional truck permitting regulations between ADOT and the region's jurisdictions	ADOT and local owning agencies	• Ensures a consistent understanding and implementation of state regulations

Goal 1: A safe and reliable multimodal freight system with the capacity to meet current and future demand			
Strategies	**Actions**	**Potential lead agency/agencies**	**Purpose**
	Explore developing a unified statewide permitting system for overweight/ overdimensional loads	ADOT and local owning agencies	• Simplifies the process for both carriers and owning agencies. May help to improve compliance to preserve infrastructure
	Expand commercial vehicle enforcement and education efforts	Owning agencies	• Improves compliance • Supports law enforcement in their efforts

Goal 2: Accessibility and connectivity of freight transport to domestic and international markets			
Strategies	**Actions**	**Potential lead agency or agencies**	**Purpose or need addressed**
2.1 Optimize the region's strategic location within the Sun Corridor.	Promote the region's available interstate-accessible lands for export-generating industries and warehousing and distribution opportunities through a variety of tools, such as Pima Parcels.	Economic development experts and jurisdictions with support from PAG	• Supports business attraction
	Monitor freight performance on the region's interstates using previously established measures.	PAG	• Meets federal requirement • Supports decision making

Goal 2: Accessibility and connectivity of freight transport to domestic and international markets			
Strategies	**Actions**	**Potential lead agency or agencies**	**Purpose or need addressed**
	Continue to work with ADOT to ensure that interstates are meeting current and future freight and passenger needs in the region.	PAG and ADOT	• Ensures interstates can continue to serve both national and local travel needs
	Identify and prioritize additional traffic interchanges for modernization and replacement.	ADOT, local jurisdictions, and PAG	• Improves interchange performance and increases interstate access
	Conduct an analysis to determine Tucson's competitive advantage for logistics hub opportunities, particularly in the areas of industrial parts and products.	Economic development experts with support from PAG	• Assists in targeting appropriate industries to grow the transportation and logistics sector
2.2 Focus freight transportation improvements in areas that serve intermodal facilities, primary job centers and other freight-intensive industry clusters.	Develop RFC design guidelines that facilitate the safe and effective movement of freight vehicles within the region.	Owning agencies and PAG	• Ensures heavily used RFCs are designed for heavy vehicles in order to reduce conflicts
	Work with Port of Tucson, Tucson Airport Authority and Davis-Monthan Air Force Base to provide efficient access to major freight facilities.	Owning agency	• Allows major intermodal facilities and special freight generators can send and receive goods more efficiently

Goal 2: Accessibility and connectivity of freight transport to domestic and international markets			
Strategies	**Actions**	**Potential lead agency or agencies**	**Purpose or need addressed**
	Periodically review and update RFC and Critical Urban Freight Corridor designations to ensure they are serving the region's freight generators.	PAG	• Ensures the region is responding to changing patterns in goods movement
2.3 Continue to work with ADOT and Sun Corridor partner agencies on topics of interregional importance.	Support efforts to improve freight movement at the Mariposa Port of Entry, including key connections to the border.	PAG	• Reduces delay at the border making bi-national commercial opportunities
	Engage partner agencies outside Pima County, such as in Pinal County, on projects and other initiatives of interregional significance.	PAG	• Projects outside of Pima County can have significant impact on travel within the region
	Participate in statewide efforts to better understand truck parking needs in and around Pima County.	PAG	• Prepares the region for growing parking needs of the trucking industry

Goal 3: Enhanced partnerships between the public and private sector to support the movement of goods and increase understanding of the importance of freight to the region's economy

Strategies	Actions	Potential lead agency or agencies	Purpose or need addressed
3.1 Incorporate freight considerations into the planning process at all levels.	Use the RFC designation in the regional transportation programming process.	PAG	• Elevates freight considerations in transportation programming
	Include RFC needs in future regional and state transportation plans to ensure they are eligible for state and federal funding.	PAG	• Elevates freight considerations in transportation planning
	Support jurisdictional decision-making by making freight data available and easily accessible.	PAG	• Supports project identification
3.2 Inform the public about freight's impact on employment and about the quality of life made possible through accessibility of products and goods.	Develop and distribute brochures and other informational pieces about freight movement in the PAG region.	PAG	• Builds wider understanding of the complexity and importance of goods movement
	Publish freight performance data for the PAG region through an online transportation dashboard.	PAG	• Tracks freight data over time to identify trends • Makes information available to stakeholders and the public
3.3 Regularly engage freight-intensive industries and carriers to ensure the region's	Actively seek to involve private partners in transportation planning efforts.	PAG	• Ensure freight issues facing system users are accurately reflected

Goal 3: Enhanced partnerships between the public and private sector to support the movement of goods and increase understanding of the importance of freight to the region's economy			
Strategies	**Actions**	**Potential lead agency or agencies**	**Purpose or need addressed**
transportation system is meeting the needs of freight.	Develop outreach methods to communicate to major freight stakeholders in order to build and maintain relationships.	PAG	• Strengthens relationships and builds trust with freight interests
	Continue to work with private entities to provide electrified parking spaces at the region's truck stops.	PAG	• Reduces air pollution from idling vehicles

Projects

The next section of this chapter focuses on specific transportation projects that are particularly important to freight movement. Projects are organized into 1) already planned or programmed projects occurring on an interstate, freeway or RFC, 2) previously identified projects that are not yet in a plan but are on an interstate, freeway or RFC and 3) new projects identified through the Freight Plan process that are important to goods movement but have not yet been identified in a regional plan. Planned and programmed projects are those that are already included in the PAG 5-year construction program (the TIP) or long-range transportation plan (2045 RMAP); unplanned projects are unfunded projects in the 2045 RMAP reserve list; and new projects were identified by jurisdictions through the Freight Plan process. Newly identified projects can be submitted for inclusion in the RMAP during the next update and then move into the TIP when funding is available. The Freight Plan does not present a financially constrained project list.

Planned or Programmed Transportation Projects

From a state and national perspective, investments in the region's interstate system will have the most far-reaching freight benefits. Improving interstate performance and, therefore, freight access into and out of the region, also will increase the region's attractiveness to those businesses that rely on efficient and reliable goods movement. **Table 5.1** shows planned and programmed projects on the region's interstates.

Table 5.1 Planned and programmed transportation projects on the PAG region's interstates (2017)

Project Name	Location	Description	Status
I-10 West Corridor	Ruthrauff Road to Ina Road	Widen to 8 lanes from Ruthrauff Road to Ina Road	Planned — widening occurring as part of interchange projects
		Ruthrauff Road interchange Improvements	Programmed for construction in 2018 — pavement widened to accommodate 8 lanes
		Sunset Road interchange Improvements	Planned
		Orange Grove Road Interchange improvements	Planned
		Ina Road interchange Improvements (includes widening of Ina Road and railroad grade separation)	Currently under construction — pavement widened to accommodate 8 lanes

Project Name	Location	Description	Status
I-10 East Corridor	I-19 to Houghton Road (I-19 to Kolb Road currently undergoing an EA process)	Widen to 8 lanes from I-19 to Kino Parkway	Planned
		Widen to 6 lanes from Kino Parkway to Alvernon Way	Planned
		Widen to 8 lanes from Alvernon Way to Kolb Road	Planned
		Widen to 6 lanes from Kolb Road to Houghton Road	Planned
		Park Avenue interchange improvements	Planned
		Kino Parkway interchange improvements	Programmed for design in 2021
		Country Club Road new interchange	Programmed for design in 2022
		Kolb Road interchange improvements	Planned
		Houghton Road interchange improvements	Programmed for construction in 2021
		Signalization of interchanges at Wilmot Road, Kolb Road, Rita Road and Colossal Cave Road	Programmed for construction in 2018
I-19 Corridor	Sahuarita Road to I-10	Widen to 6 lanes from San Xavier Road to Ajo Way	Planned (with portions widened as part of the Ajo interchange project)
		Sahuarita Road interchange improvements	Planned
		Irvington Road interchange improvements	Programmed for design in 2021
		Ajo Way interchange improvements	Under construction

Beyond projects on the existing interstate system, several large-scale corridor projects are currently under study that could have a considerable impact on traffic regional movement. Given their location and scale, these projects could be especially beneficial for over-the-road freight movement. The projects include the SR 210 extension, the SR 410 Sonoran Corridor project and the SR 189 project in Nogales, Arizona.[106] Project status is shown in **Table 5.2**.

IN FOCUS: I-10 EAST CORRIDOR

Table 5.1 indicates that most interstate improvements planned or programmed in the region are occurring on the I-10 east corridor. This is largely owing to the fact that the corridor, which is defined for PAG's planning purposes as the stretch of I-10 that runs from the I-19 junction to SR 83, has not added any significant capacity since its initial construction. The corridor still has a four-lane configuration with a number of outdated interchanges. As a result, increasing traffic volumes have contributed to reduced operational effectiveness. In contrast, I-10 west of the I-19 junction has seen a number of major capacity projects in recent years, in particular the widening from I-19 to Ruthrauff Road. Planned projects on the I-10 west corridor will extend the eight-lane configuration north to Ina Road in the coming years.

While I-10 west experiences higher overall traffic and connects the PAG region to its largest trading partners in Los Angeles and Phoenix, I-10 east is the primary interstate corridor serving multiple industrial areas, freight-generating enterprises and targeted economic growth opportunity areas. The industrial zone west of DMAFB connects t I-10 east via Alvernon Way and Palo Verde Road; the Port of Tucson has its interstate access at Kolb Road and Wilmot Road; and the University of Arizona Tech Park is located just off I-10 east at Rita Road. Additionally, freight traveling eastbound from the major employment clusters near Tucson International Airport accesses the interstate system on I-10 east at Valencia Road or Los Reales Road.

Near-term improvements to the corridor include signalization of interchanges to prevent the backup of traffic onto the interstate, while longer-term improvements include modernization of interchanges and widening of the mainline to six or eight lanes. Part of these improvements includes an extension of SR 210 from Palo Verde Road to connect with I-10 east in the vicinity of DMAFB. The section of the I-10 east corridor between I-19 and Kolb is currently undergoing an EA by ADOT. The EA will establish future lane configurations and determine the location of the SR 210 tie-in. When funding becomes available, future studies will be conducted for the section of the corridor east of Kolb Road.

[106] Note that the SR 189 project is outside of the PAG planning area, but the project has regional support because of the benefits to cross-border freight movement and commerce.

Table 5.2 Other significant corridor projects

Project Name	Location	Description	Status
SR 210: Barraza-Aviation Parkway Extension	Palo Verde Road to I-10	Construct new corridor	Planned — currently under study as part of the ADOT I-10 East/SR 210 EA
SR 410: Sonoran Corridor	I-10 to I-10 South of Tucson International Airport	High-capacity multimodal facility connecting the interstates	Planned — corridor alternatives being studied through ADOT Tier 1 EIS
SR 189 Improvements	International Border to Grand Avenue (Nogales, AZ)	Improve corridor to support international commerce	Draft EA completed — programmed for construction in 2019

Finally, in addition to interstate and significant corridor projects, 30 transportation projects are planned or programmed on the non-interstate RFC network over the next 30 years. These are projects that improve corridors deemed particularly important to freight movement within the region. Because the projects are occurring on the RFC network, they are assumed to have a significant benefit to freight as well as to the overall traveling public. **Table 5.3** includes planned and programmed transportation projects located on the RFC network.

Table 5.3 Planned and programmed projects on the RFC network

Project name	Location	Description	Status
22nd Street #1	I-10 to Tucson Boulevard/Barraza-Aviation Parkway	Widen to 6-lane divided roadway with **bridge over railroad** and bike lanes	Programmed for construction (RTA project)
Aerospace Pkwy.	Nogales Highway to Alvernon Way	Widen to 4-lane roadway with bike lanes and sidewalks	Programmed for construction
Alvernon Way Corridor Project	Aerospace Parkway to Fort Lowell Road	Widen to 4 and 6 lanes with street lights, sidewalks, storm drains and bus pullouts	Planned
Avra Valley Road #2	Clayton Road to I-10	Widen to 4-lane roadway, re-align, multipurpose lanes and sidewalks	Planned

Project name	Location	Description	Status
Grant Road Corridor Project	Mountain Avenue to Swan Road	Widen to 6-lane roadway with bike lanes, sidewalks and streetscaping	Programmed for construction (RTA project)
Houghton Parkway #2	Dawn Road to I-10	Widen to 4-lane divided roadway with sidewalks and bike lanes	Planned
Houghton Parkway #3	I-10 to Tanque Verde Road	Widen to 4- and 6-lane parkway with **new bridges** and greenway, bike lanes and sidewalks	Programmed and under construction (RTA project)—first three project phases already completed.
Ina Road #2	Silverbell Road to I-10	Widen to 4-lane roadway, includes bridges	Under construction (RTA project)
Ina Road #3	I-10 to Camino de la Tierra Road	Widen to 6-lane roadway	Planned
Irvington Road #3	Santa Cruz River to east of I-19	Improve intersections, provide access management, bike lanes and sidewalks	Planned (RTA project)
Kolb Road #1	I-10 to Escalante Road	Widen to 6-lane roadway with bike lanes, sidewalks and drainage	Planned (partially programmed for design from Escalante to Valencia. Intersection improvements at Kolb and Valencia construction in 2018.)
La Cholla Boulevard	Overton Road to Tangerine Road	Widen to 4 lanes	Programmed for construction
Nogales Highway #1	Old Vail Connection Road to Los Reales Road	Widen to 6-lane roadway with sidewalks and bike lanes	Planned
Railroad Grade Separation at Cortaro Farms Road	Cortaro Farms Road	Construct grade-separated railroad crossing	Planned

Project name	Location	Description	Status
Railroad Underpass at Grant Road	Union Pacific Mainline and Grant Road	Expand railroad underpass east of I-10 to accommodate 6 lanes	Planned (RTA project)
Sahuarita Road	Country Club Road to SR 83	Reconstruct 2-lane roadway with drainage, bike lanes	Planned
Sahuarita Road #1	La Cañada Drive to La Villita Road	Widen to 6-lane roadway	Planned
Sandario Road	Ajo Way to Emigh Road	Reconstruct 2-lane roadway, bike lanes	Planned
SR 77 #1: Miracle Mile Road	I-10 to Oracle Road	Widen to 6-lane roadway	Planned
SR 77 #2: Oracle Road	Rudasill Road to Ina Road	Widen to 8-lane roadway	Planned
SR 77 #3: Oracle Road	Ina Road to Magee Road	Widen to 8-lane roadway	Planned
SR 86 #A (Ajo Highway	Sandario Road to Valencia Road	Widen to 4-lane divided roadway	Planned
SR 86 #D (Ajo Way)	Mission Road to I-19	Reconstruct and widen to 6 lanes	Planned
SR 86 #E (Ajo Way)	I-19 to I-10	Widen to 6-lane roadway	Planned
Tangerine Road	I-10 to La Cañada Drive	Widen to 4-lane divided roadway with bike lanes, multi-use lanes, sidewalks and drainage	Planned/Programmed (RTA project) — Phase 1 from La Cañada Drive to Dove Mountain Boulevard completed in 2018; Phase 2 construction from Dove Mountain Boulevard to I-10 will begin after 2022
Valencia Road #2	Ajo Highway to Mark Road	Widen to 4-lane roadway with bike lanes and sidewalks	Planned/Programmed (RTA project) — Wade Road to Mark Road completed in 2016; Ajo Highway to Wade Road will begin construction in 2018.

Project name	Location	Description	Status
Valencia Road #3	Camino Verde Road to Mission Road	Widen to 6-lane roadway with bike lanes and sidewalks	Planned
Valencia Road #4	I-19 to Alvernon Way	Access management & safety improvements	Planned (RTA project)
Valencia Road #5	Wilmot Road to Kolb Road	Widen to 6-lane roadway with bike lanes and sidewalks	Programmed for construction (RTA project)
Valencia Road #6	Kolb Road to Houghton Road	Widen to 6-lane roadway with bike lanes and sidewalks	Programmed (RTA project) — design work expected to begin in 2019

Unfunded Identified Transportation Projects

The following tables present transportation projects that have a freight benefit, either due to being located on an interstate system or an identified RFC route, but which cannot be reasonably expected to be funded under current regional revenue projections (through 2045). These projects have been identified by jurisdictions in Pima County and appear in PAG's 2045 RMAP on the "reserve list." These are projects that can be pursued if more transportation funding becomes available, if project priorities change in the next long-range plan update, or after 2045. The only exception is Interstate 11 (I-11) from Nogales to Wickenburg. The I-11 project is currently under study and has not appeared in any financially constrained PAG plans. **Table 5.4** shows unfunded projects on the interstate, while **Table 5.5** shows unfunded projects on the RFC network.

Table 5.4 Interstate projects with no identified funding

Interstate section	Project name	Location	Description
I-10 West	I-10 West Phase 2: Prince Road to Marana Road	Prince Road to Marana Road	Widen to 10 lanes
	I-10 West Phase 3: Marana traffic interchange (TI) to N. County Line	Marana TI to N. County Line	Widen to 10-lanes
	Avra Valley/ Lambert TI	I-10 and Avra Valley Road	Reconstruct TI

Interstate section	Project name	Location	Description
	Tangerine Road TI	I-10 and Tangerine Road	Reconstruct TI with railroad grade separation
	Moore Road TI	I-10 and Moore Road	Construct TI
	Marana Road TI	I-10 and Trico-Marana Road	Construct TI
	Pinal Air Park TI	I-10 and Pinal Air Park Rd	Reconstruct TI
	Tortolita Boulevard TI	1.3 mi SE of Pinal Airpark TI	Construct TI south of County Line
I-10 East	I-10 East Phase 3: Alvernon Way to Kolb Road	Alvernon Way to Kolb Road	Widen to 10 lanes
	I-10 East Phase 2: Kolb Road to Houghton Road	Kolb Road to Houghton Road	Widen to 8 lanes
	Valencia Road TI	I-10 and Valencia Road	Reconstruct TI
	Craycroft Road TI	I-10 and Craycroft Road	Reconstruct TI
	Wilmot Road TI	I-10 and Wilmot Road	Reconstruct TI
	Rita Road TI	I-10 and Rita Road	Reconstruct TI
I-19	I-19: Mainline Widening #1	Continental Road to El Toro Road	Widen to 6 lanes
	I-19: Mainline Widening #2	El Toro Rd to Valencia Rd	Widen to 6 lanes
	TI #2 at Pima Mine Road	I-19 and Pima Mine Rd	Reconstruct TI
	TI #3 at San Xavier Road	I-19 and San Xavier Road	Reconstruct TI
	TI #4 at Drexel Road	I-19 and Drexel Rd	Construct TI and bridge over Santa Cruz

Interstate section	Project name	Location	Description
	TI #7 at El Toro Road	I-19 and El Toro Road	Construct interstate TI at El Toro Road
I-11 Study	Nogales, AZ, to Wikenburg, AZ	Three-year environmental study to consider possible routes between Nogales and Wickenburg	Tier 1 EIS in process — no projects associated with I-11 currently listed in PAG plans

Table 5.5 Identified projects on RFC network with no funding

Project name	Location	Description
Benson Highway	Kino Parkway to Irvington Road	Widen to 6-lane roadway
Nogales Highway #3	Pima Mine Road to Old Vail Connection Road	Widen to 4-lane roadway
Nogales Highway #4	Sahuarita Road to Pima Mine Road	Widen to 4-lane divided roadway
Orange Grove Road #1	I-10 to Thornydale Road	Widen to 8-lane roadway
Twin Peaks Road #2	Sanders Road to Sidewinder Lane	Widen to 4-lane roadway

IN FOCUS: I-11 NOGALES TO WICKENBURG STUDY

In March 2016, FHWA and ADOT initiated an environmental review process for a portion of the I-11 Corridor from Nogales to Wickenburg. An Alternatives Selection Report (ASR) and Tier 1 EIS will be prepared as part of this process in accordance with NEPA and other regulatory requirements.

The Tier 1 EIS and ARS build on a previous study, completed in 2014, known as the I-11 and Intermountain West Corridor Study (IWCS). The IWCS defined, in broad terms, the I-11 corridor from the Mexico border to northern Nevada. The purpose of the I-11 Nogales to Wickenburg Tier 1 EIS, then, is to take the next step in the process and narrow the IWCS corridor to a Preferred Alternative for the southern portion of the study area. The Preferred Alternative will then be submitted to FHWA for a Record of Decision and identification of a Selected Corridor Alternative.

I-11 is intended to serve as a high-priority, access-controlled, north-south transportation corridor through Arizona, which will more directly connect Tucson, Phoenix and Mexico to Las Vegas and beyond. I-11 in Arizona comprises the southern section of the CANAMEX Corridor, which, when fully realized, will connect Mexico to Canada via Tucson, Phoenix, Las Vegas, Salt Lake City and Great Falls along I-19, I-10, I-11 and I-15. This connection will improve market access for Pima County's goods and increase the region's importance as a gateway to the corridor. Funding has not yet been identified for I-11 in Arizona, and a potential horizon for construction is undetermined.

More information on the I-11 study can be found at http://i11study.com/Arizona/index.asp.

New Freight Transportation Projects

Overall, freight stakeholders and PAG member jurisdictions indicated that the roadway system is largely serving the needs of freight in the region. A review of data from ATRI supports this position. The primary challenge facing the freight highway system comes from the anticipated effects of future population growth and economic growth on traffic volumes. Many of these challenges are addressed on the region's freight corridors through the planned and programmed projects shown previously (**Tables 5.1, 5.2 and 5.3**). However, in the course of developing the Freight Plan, jurisdictions and other stakeholders identified other projects that would be beneficial to freight movement. These projects, shown in Table 5.6, have yet to be submitted by the region's jurisdictions for consideration in a financially constrained long-range transportation plan and are, therefore, currently ineligible for federal or regionally planned state transportation dollars. To be considered for such funding, the projects would need to be sponsored by the owning agency and included in future updates of the long-range plan.

Table 5.6 Projects identified through the Regional Freight Plan

Project name	Location	Description
La Cholla Boulevard extension	Moore Road to north of the Pima County line	Extend La Cholla Boulevard to connect with SR 77 or SR 79 north of the Pima County line; will provide a parallel alternative corridor to Oracle Road
Davis-Monthan Air Force Base Freight Gate relocation	Wilmot Road north of Valencia Road	Relocate DMAFB freight gate from Golf Links Road and Swan Road to relieve morning congestion and vehicles backing up on Golf Links Road; improvements on Wilmot Road are programmed to support this project
Traffic interchange upgrades and modernization	Multiple	This category of projects was identified as a priority to improve interstate access and safety. Many interchange improvements are already planned or programmed, and others have been identified but are currently unfunded.
Railroad grade separation	Multiple	Additional railroad grade separations will improve mobility and reduce conflicts between trains and passenger travel. To determine which corridors' grade separations would be most beneficial, the region may conduct a study to prioritize locations based on costs and stakeholder benefits.

Freight Performance Measures

Federal law requires that MPOs and states track the performance of various elements of the transportation system through the development of performance measures and targets. To comply with the legislation, PAG established regional performance measures and targets for the first time in the 2045 RMAP. However, at the time of the RMAP's approval, freight-focused performance measures were not yet available for the region. Since the RMAP was approved, FHWA finalized the rule for the required freight performance measure, while PAG collected additional data to establish baselines and develop a better understanding of freight performance areas. Because it is important that the data-supporting performance measures are comparable over time, and publicly available data only cover certain portions of the road network, most freight performance data is limited to state routes, interstates and the non-interstate National Highway System (NHS).[107] Even with the limited coverage of these publicly available data, tracking performance over time will enable the region to better understand overall freight trends, though not necessarily on specific corridors. Periodic acquisition of propriety third-party data, such as ATRI, can provide a point-in-time comparison with public datasets while supplying freight volume and delay data for the entire regional roadway network.

Table 5.7 shows which data and performance measures PAG is committed to tracking on an annual basis. The Truck Travel Time Reliability (TTTR) Index on the interstate system is the only federally required freight performance measure.

Beyond the freight data in **Table 5.7**, PAG also will continue to monitor freight volumes on the regional road network by conducting annual classification counts. The counts occur at around 100 locations regionally each year (out of a total of around 300 total annual traffic count locations). Classification counts provide information over a 48-hour period on which type of vehicle is traveling through the counted location. Data are provided in 15-minute increments.[108] In the coming years, classification counts can be more focused on the RFC network to monitor truck activity on those specific corridors. Monitoring selected additional corridors outside of the RFC network also will be done to support periodic revisions to the RFC network designation.

[107] The National Highway System (NHS) includes the Interstate Highway System as well as other roads important to the nation's economy, defense and mobility. The NHS was developed by the U.S. Department of Transportation in cooperation with the states, local officials, and MPOs. The non-interstate NHS in the PAG region is very limited, encompassing only those corridors connecting to intermodal facilities and strategic defense assets. For a map of the NHS in the PAG region visit https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/arizona/tucson_az.pdf.

[108] PAG's traffic count data, including classification counts, can be accessed at http://pag.ms2soft.com.

Table 5.7 Regional freight performance measures and data tracking

Performance Measure/Data	Description	Origin	Network Coverage	Source Data	2015 Baseline
TTTR Index	Measure of reliability on the interstate created by dividing 95th percentile travel time by 50th percentile travel time for 5 time periods	Federal requirement	Interstates	National Performance Management Research Data Set (NPMRDS)	Unavailable
Freight Delay	Measure of the amount of time, in hours, trucks lose to congestion in the PAG region.	2045 RMAP	Interstates and NHS	NPMRDS	NHS: 2.38 hours
					Interstate: 0.74 hours
Freight Share	Measure of the percentage of commercial vehicles on a roadway as a total of all traffic volume	2045 RMAP	Interstates and state routes	ADOT continuous traffic counts	I-10: 13%
					I-19: 3%
					SR 77: 2%
					SR 83: 2%
					SR 86: 1%

Summary

Overall, the region's transportation network is largely serving the current needs of freight. However, if no operational or capacity investments are made in the system, future congestion issues, caused by growth in both commercial and passenger travel, would increase freight delay and reduce reliability. To that end, significant investments are already planned or programmed on the region's most important over-the-road freight corridors. Other capacity improvements, particularly on the interstate, have been identified, but no funding is foreseen to be available for these projects. Currently under study are a few high-profile projects that, if and when completed, would improve connectivity between the PAG region and national and international markets, leveraging the region's position in the Sun Corridor. These include the Sonoran Corridor, I-11 and SR 189.

Multiple strategies and actions have been identified by PAG member agencies and freight stakeholders to maintain the effectiveness of the freight transportation system, take advantage of emerging opportunities and improve the operating environment for shippers and carriers. PAG is committed to expanding freight-related data tracking to provide a decision-support tool for future transportation initiatives.

6

Conclusion

6. Conclusion

This chapter provides a summary of the Freight Plan, identifies findings and takeaways, and provides a brief overview of roles associated with next steps to support future transportation decision making.

Overview

The Freight Plan provides an overview of the operational, regulatory and infrastructure needs of the regional freight system and connects them to the state of the region's economy. The goals and strategies of the plan are based on input received from private users of the freight system (such as regional shippers and freight carriers), public agencies, and analysis of economic and freight datasets, including TRANSEARCH commodity flow and ATRI GPS data.

The Freight Plan, while relying on regional employment and economic data, is not intended to be a comprehensive economic development plan for the region. Issues such as workforce development and education, incentives and business attraction strategies, employee access, and incubation of non-goods-producing industries are outside the scope of this effort. These are issues best left to jurisdictions and economic development agencies, such as Sun Corridor Inc. Instead, the Freight Plan exists to complement economic development efforts by providing information about how well the regional freight system is serving the needs of the region's economy and to identify what actions and investments can be made to assure that it continues to support economic growth (or at least not inhibit it).

The main outcomes of the Freight Plan include an analysis of the performance of the freight system, including commodity flows; the creation of new Regional Freight Corridor and Critical Urban Freight Corridor designations; development of freight-specific goals and actions; identification of which planned or programmed transportation improvements are expected to be particularly beneficial to freight movement; and identification of additional projects and project categories for consideration in future regional plans.

Findings and Takeaways

The following is a list of the key findings and takeaways from the Freight Plan. Some of the findings are confirmation, albeit with a freight emphasis, of what is already understood about the region, while others offer new insights as to how freight is using the region's transportation system, distinct from passenger vehicles.

- The PAG region’s economy is largely service-based, with high concentrations of employment in retail, leisure, administrative services and healthcare, as well as in the public sector. The high share of employment in lower-wage industries has been a contributing factor in below-average per capita incomes as well as vulnerability to economic slowdowns.
- Compared with peer regions, Tucson has a relatively low share of freight-intensive employment and employment in goods-producing industries. Growing export-based industries could have a significant multiplier effect on regional GDP and employment. One area of strength is employment in advanced manufacturing, particularly in the aerospace and defense sector. Because of this strength, regional wages and salaries for manufacturing are well above the national average. Approximately 40 percent of freight value generated in the region is estimated to come from Raytheon Missile Systems.
- Owing to its location along a major interstate and between two large markets, the PAG region experiences a significant amount of pass-through freight traffic. In 2013, 77 percent of truck freight (by value) traveling on Pima County roadways was passing through the region. The majority of pass-through freight is traveling from west to east. Nearly 40 percent of pass-through freight originates in Los Angeles (including the ports); most of it is destined for Texas.
- Opportunities for increasing freight-intensive economic activity in the PAG region include a concentration of high-performing freight infrastructure assets, such as two interstates, a Class I railroad line, a truck-to-rail intermodal facility, an international airport, and gas and liquid petroleum pipelines; supply chain opportunities resulting from proximity to the Mexican border; considerable acreage of available industrial land with high interstate access; relatively low costs; and an established advanced manufacturing sector.
- Most freight activity in the region occurs in the following areas:
    - south and east of Tucson International Airport
    - west of Davis-Monthan AFB along South Alvernon Way and South Palo Verde Road
    - on South Park Road between 22nd Street and State Route 210
    - along I-10 from Grant Road to Prince Road
    - at Avra Valley Road and I-10
    - from the copper mines near Green Valley and Sahuarita
    - on South Rita Road, near the UA Tech Park
    - around the Port of Tucson
    - near Innovation Park at the intersection of Tangerine and Oracle roads

The corridors serving these locations have been identified as RFCs, which can be used as a decision-support tool for transportation planning and programming.

- An analysis of freight GPS data and interviews with stakeholders and jurisdictions indicate no current significant capacity issues with the region's freight roadway network. Because freight peak occurs outside of the passenger peak traffic period — and most freight generators are located close to interstates — freight traffic is less affected by recurring morning and evening congestion. Future anticipated passenger and commercial traffic growth could change this situation. Fortunately, many identified freight corridors have future capacity improvements already planned or programmed.
- Apart from needed capacity improvements to address future traffic growth, the Freight Plan identified pavement condition, bridge condition, at-grade railroad crossings, traffic interchange modernization and traffic signal timing as critical concerns for freight movement. Further study to explore each of these issues in more detail may be warranted.
- Interstate traffic is expected to grow considerably in the coming years due to an increasing number of regional commuters combined with growth in interstate truck traffic. To address this growth, several significant interstate projects are currently under construction, programmed or listed in the region's long-range plan. In the near future, once planned interchange projects are completed—plus taking into account the addition of recent capacity projects in the downtown area—I-10 will have been upgraded and widened from the I-19 interchange all the way north to Ina Road. These interstate improvements address many of the most of pressing needs on the corridor. Future focus for expansions may then shift to I-10 east between I-19 and Houghton Road. Not only has I-10 east not seen significant capacity improvements since it was first constructed in the middle of the 20th century, but it is also the primary corridor serving many of the region's largest freight generators and targeted economic growth zones.
- The SR 410 (Sonoran Corridor), SR 189, and I-11 project proposals, currently under study by ADOT, could have significant impacts on freight and passenger movement in the PAG region if constructed. The SR 410 and I-11 projects, specifically, could be the largest transportation investments made in the region in several generations.
- PAG is committed to monitoring freight performance on the region's interstates and major roadways using publicly available truck data and a more focused use of traffic classification counts. Future acquisitions of proprietary data also can be pursued depending on funding availability and regional priorities.

Implementation

The Freight Plan identifies project needs and actions that can be implemented in the coming years to benefit the regional freight system.

Freight Transportation Project Development

Although many of projects listed in the Freight Plan are already included in the 2045 RMAP, there is no guarantee funding will be available for identified improvements (this is different than those projects that are already programmed in the TIP or that are in the FY 2007-2027 Regional Transportation Authority plan; those projects are expected to be fully funded). Including unfunded but planned projects in the Freight Plan helps indicate which corridor improvements would be assumed to benefit both commercial and personal travel needs. This can assist with decision making when it comes time to prioritize transportation improvements in future planning and programming efforts.

Newly identified freight projects and RMAP reserve list projects, which are assumed to be beyond the region's estimated transportation revenues, can be considered for inclusion in the financially constrained project list in future updates of RMAP. Once moved to the financially constrained list, these projects would be eligible for TIP regional funding.

Regional Freight Plan Actions

Freight Plan actions (presented in the Goals, Strategies and Actions table in Chapter 5) are divided between those that would be undertaken by PAG and those that would be the responsibility of owning agencies. PAG actions focus more on studies, data collection, planning efforts and other freight-supportive initiatives. In order for PAG to pursue these activities, they must be included in the Overall Work Program (OWP) for the organization, which will allow resources to be dedicated to the activity. PAG's OWP is updated annually.

Actions for the owning agencies should be treated as recommendations that they can use to support future investment decisions or for pursuing regional or federal funding opportunities. Referencing inclusion in an approved Freight Plan can serve as a rationale for various activities by demonstrating that they were generated and approved through a regional process and are consistent with established transportation goals. Listing an action in the Freight Plan does not guarantee the action will occur but instead enables and encourages the region to pursue certain activities. Whether or not a listed action happens depends on availability of resources and balancing of regional priorities.

Summary

The Freight Plan marks the first time PAG has pursued a data-driven freight effort. Development of the Freight Plan has provided a better understanding of the current flow of goods on the region's transportation system and future system needs to ensure ongoing efficiency of freight movement and support regional economic vitality. The Freight Plan addresses, in a more comprehensive manner, the federal emphasis on ensuring that transportation planning includes a discussion of freight needs and considers economic factors in transportation decision making. The Freight Plan establishes a foundation and direction for the PAG freight program and will elevate freight considerations in all future transportation planning work.

7

Appendices

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Appendix 1

Pima County Commodity Flow Study

CPCS

www.cpcstrans.com

Commodity Flow Study

Final Report

Prepared for:

Pima Association of Governments

Prepared by:

CPCS

Solutions for growing economies

CPCS Ref: 16600
August 8, 2017

Cover image source: iStockPhoto

Executive Summary

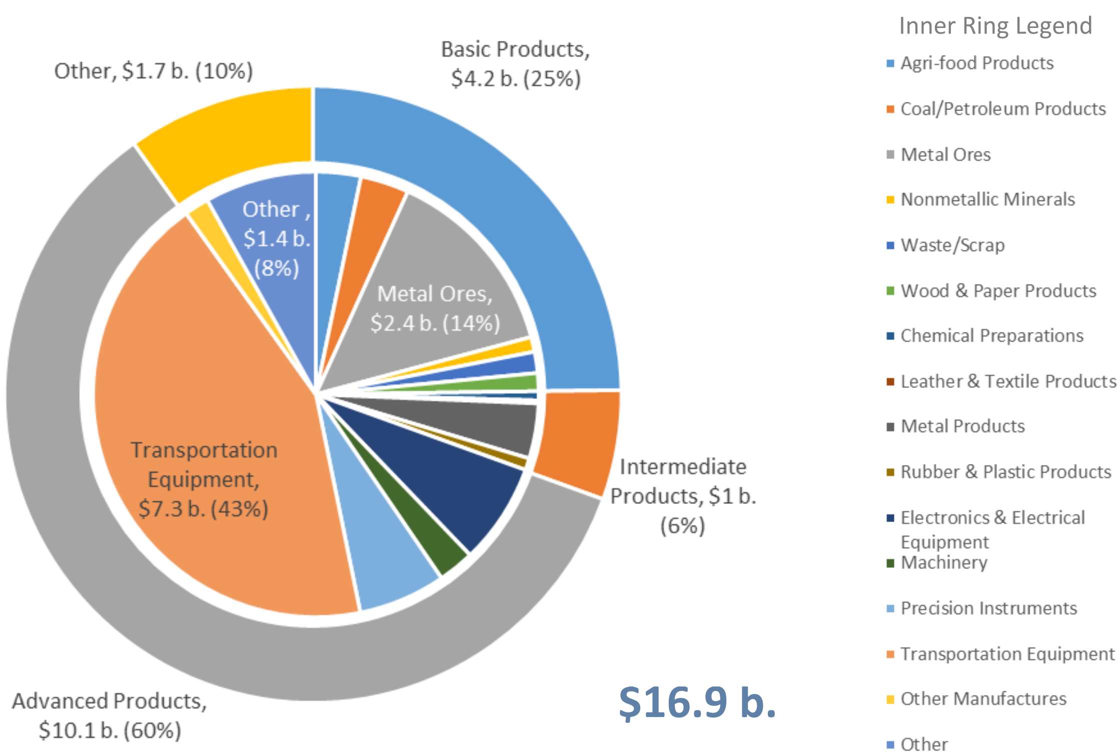
The purpose of this study is to describe commodity flows in the Tucson area (Pima County), and to investigate how these observations fit into the larger narrative of freight flows in Arizona and the broader economic context of the region. The study also includes a benchmarking component comparing Tucson with other similar regions, as well as a special focus on advanced product outflows and through-flows.

The primary data source for this study is Transearch (2013), supported by other data sources, including the Freight Analysis Framework (FAF4.3) and County Business Patterns.

Missiles dominate outbound flows

The top commodities that make up total outflows from Pima County (by value) are Transportation Equipment, Metal Ores, and other (including warehouse/distribution center shipments), as shown in Figure ES-1. Transportation Equipment includes notably missiles produced in Tucson, while Metal Ores consists largely of copper mined in Pima County and sent by rail for smelting in Gila County.

Figure ES-1: Total Outflows from Pima County (By Value)



Source: CPCS analysis of Transearch (2013)

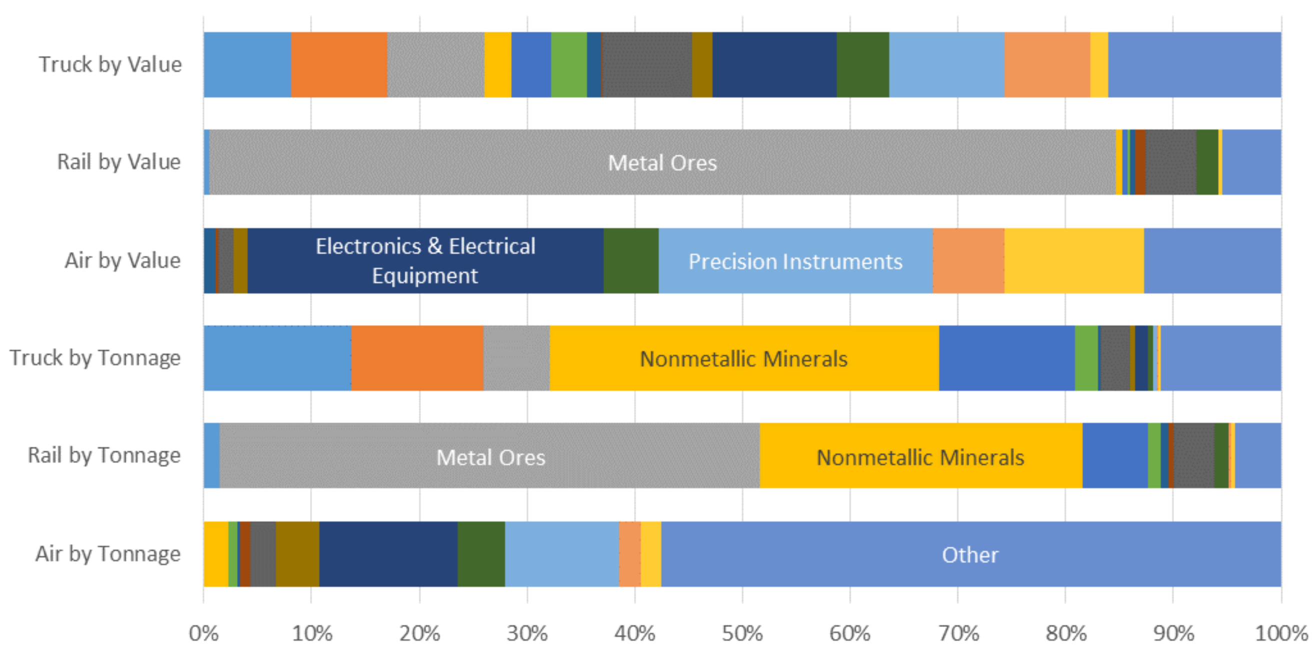
There are also significant outflows of other Advanced Products, including Electronics and Electrical Equipment, and Precision Instruments. The market for these Advanced Products is national or international.

In the figure, the outer ring displays the four high-level commodity categories. The legend on the right-hand side shows the commodities in greater detail (these correspond to the inner ring, clockwise from the top). In other words, the inner ring shows a more detailed breakdown of the outer ring.

Rail is dominated by Metal Ores, truck is critical for all commodities

Overall, 65% of outflows (by value) are by truck, 21% by rail, and 14% by air. As shown in Figure ES-2, truck outflows from Pima County are fairly balanced between different commodities (except when assessed by tonnage, in which case Non-metallic Minerals such as sand/gravel are over 30%). Rail shipments are dominated by Metal Ores, notably copper. For air, the top commodity categories by value are Electronics and Electrical Equipment, and Precision Instruments. By tonnage, the "other" category for air is largely small package shipments.

Figure ES-2: Commodity Breakdown by Mode, Outflows from Pima County (Value and Tonnage)

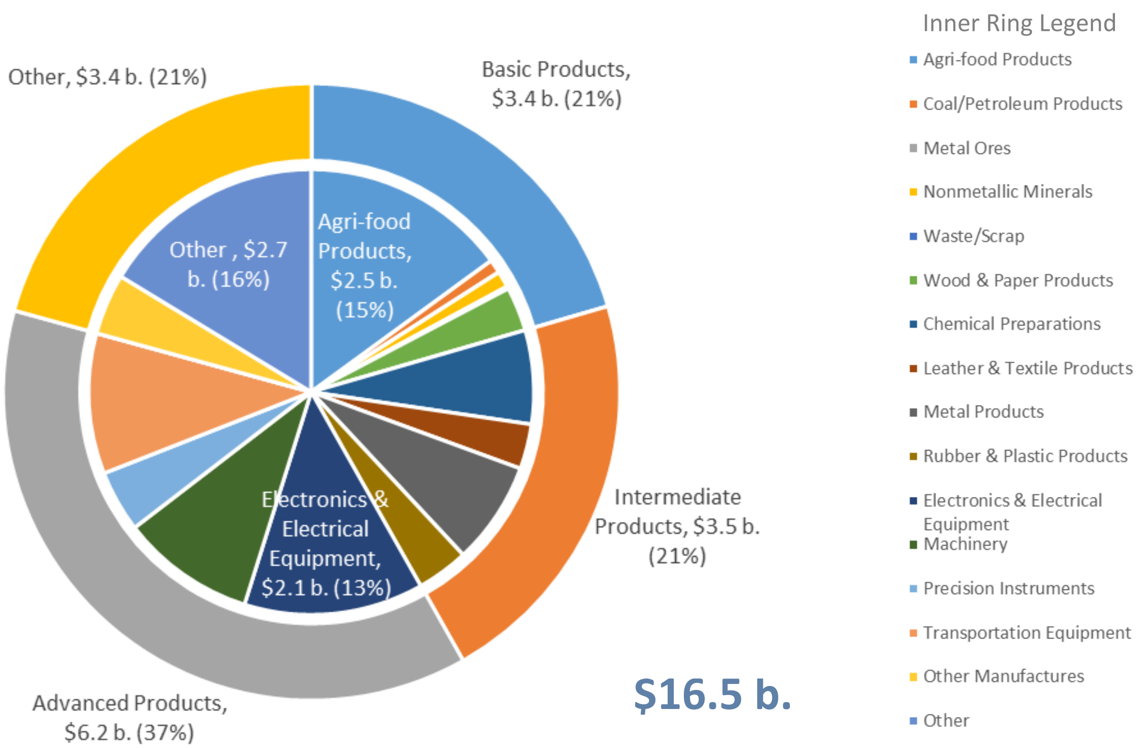


Source: CPCS analysis of Transearch (2013). Note: Transportation Equipment does not include $6.7 b. in missile/space vehicle parts (destination not identifiable through Transearch)

Inbound flows are balanced between commodity groups

For total inflows to Pima County, shown in Figure ES-3, the top commodity category by value is "other" (16%), which largely consists of warehouse/distribution center shipments, notably from Maricopa County or the Los Angeles area. The second highest commodity category is Agri-food Products (15%), a large share of which is from Mexico or California. Other significant inflow categories include electronics and electrical equipment (13%, including industrial equipment as well as consumer electronics), Transportation Equipment (10%, including motor vehicles), and machinery (10%). Chemical Preparations, at 7%, consists largely of pharmaceuticals.

Figure ES-3: Total Inflows to Pima County (by Value)



Source: CPCS analysis of Transearch (2013)

Freight-related employment is fairly low, manufacturing drives up wages

When compared to 30 other U.S. metropolitan areas of comparable population, the Tucson metropolitan statistical area (defined as Pima County) has a below-average number of freight-related jobs as a share of total employment. Freight-related employment is defined as employment in sectors including construction and natural resources; manufacturing; and transportation, warehousing, and wholesale trade. Tucson does have above-average employment in construction and natural resources (which includes mining), but ranks last out of 31 in transportation and wholesale trade (Figure ES-4). Tucson has a high proportion of retail and non-retail service jobs, which are driven by the tourism economy as well as the above-average proportion of retirees (which increases demand for healthcare services).

Figure ES-4: Tucson Freight-Related Employment, as Percentage of Jobs, versus Comparator MSAs

	Constr. & Raw Mat'l	Mfg	Transp & Whls Trade	Retail	Non-Ret Service	Office
Tucson, AZ	6%	7%	4%	29%	37%	15%
Average, 31 Cities	6%	9%	8%	25%	34%	17%
Tucson Rank	10	17	31	5	3	22

Source: CPCS analysis of County Business Patterns data (2014). MSA = Metropolitan Statistical Area.

Similar trends are observed for comparisons to Making Action Possible (MAP) Dashboard[1] cities. Payroll per employee in freight-related sectors is fairly low in Tucson, with the exception of the manufacturing sector. (Although Pima County notably does have well-paying mining jobs, employment in the Construction and Raw Materials category is largely dominated by construction industry, in which other cities have higher average wages).

Aside from being indicative of wages paid to employees, payroll of freight-generating establishments can also be considered something of a proxy for the value of freight generation. It appears that this high payroll per employee is largely related to Transportation Equipment (including missile) manufacturing. Figure ES-5 shows payroll per employee by sector for MAP Dashboard cities.

Figure ES-5: Payroll per Employee by Sector, Tucson vs. MAP Dashboard MSAs

	Constr. & Raw Mat'l	Mfg	Transp & Whls Trade	Retail	Non-Ret Service	Office	All Sectors
Tucson	$45,539	$75,133	$49,348	$21,277	$34,990	$54,918	$38,734
Average, 12 Cities	$53,091	$58,120	$58,950	$23,146	$38,406	$68,053	$44,622
Tucson Rank	11	1	11	11	11	10	10

Source: CPCS analysis of County Business Patterns data (2014). MSA = Metropolitan Statistical Area.

Aside from missiles, optical and scientific equipment are important outflows

Growing advanced product outflows is a stated goal of regional economic plans. Currently, if all missile production is assumed to be destined for out-of-state, missile production comprises 71% of out-of-state advanced product flows, which is an indicator of their importance to the regional economy but also an argument for continuing to develop other high-tech export industries. Figure ES-6 highlights the top non-missile advanced product outflows for Pima County, with Maricopa County listed for comparison. Currently, Pima County has greater outflows of optical and scientific equipment, while Maricopa County specializes in electrical equipment, semiconductors and transportation equipment (including spacecraft).

[1] Making Action Possible for Southern Arizona (mapazdashboard.arizona.edu)

Figure ES-6: Selected Top Advanced Product Commodities (Out-of-State Outbound), $M.

Detailed Commodity	Category	Maricopa County	Pima County
Electrical Equipment	Electronics & Elec.	$4,427	$471
Misc. Electrical Industrial Equipment	Electronics & Elec.	$1,660	$414
Engineering, Laboratory or Scientific Equipment	Precision Instr.	$12	$389
Instrum. Photo Equipment, Optical Eq.	Precision Instr.	$107	$363
Solid State Semiconductors	Electronics & Elec.	$3,637	$99
Transportation Equipment	Transportation Eq.	$1,453	$89

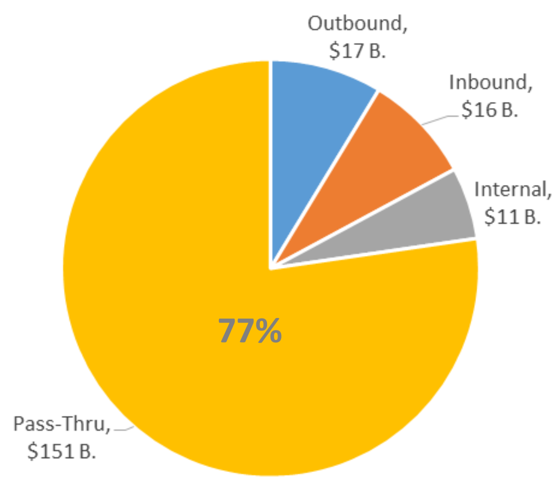
Source: CPCS analysis of Transearch data (2013) *Does not include $6.7 in missile or space vehicle parts for Pima County

Through-flows are significant, largely dominated by Los Angeles to southern U.S. trucking

Another stated regional economic goal is developing logistics hub/cluster-type functions in the Tucson area, to capture some value from pass-through flows through the region.

At present, pass-through truck flows are significant, at 77% of all flows in the Tucson region (including inbound, outbound, and internal) (Figure ES-7). Approximately half of the pass-through flows are domestic flows from the Pacific (especially the Los Angeles area, including the ports of Los Angeles and Long Beach) to consumers in the Southwest (including Texas) and Southeast. Flows to/from Mexico (truck and rail) are also significant.

Figure ES-7: Truck Through-Flows as a Share of All Truck Flows in Pima County



Source: CPCS analysis of Transearch data (2013)

The top pass-through commodity categories by truck are Agri-food Products, Electronic and Electrical Equipment, Machinery, Leather and Textile (apparel), metals, and chemicals. Some of these, such as apparel, are very linear in their flows, with 83% of all apparel pass-through flows destined from the Los Angeles area to domestic destinations east of Tucson (such as Texas), along the I-10.

An analysis was performed to reveal commodities with geographic balance in their origins and destinations, including south to Mexico, west to Phoenix/California, and east to Texas and beyond. Many of the commodities with the most geographic balance are industrial parts and products.

Conclusions

Missiles are a major contributor to the regional economy, and their share of Advanced Products outflows is high. Tucson is also home to "Optics Valley," a cluster of optics companies. Taking advantage of linkages with the University of Arizona, as well as developing the talent pipeline overall, remains important for growing a diversified export economy in advanced manufacturing and increasing the number of high-paying jobs that come with it.

Future studies could build on this work to reveal specific high-tech industries that could be expanded in Tucson, potential untapped/underutilized markets for outbound products, and potential supply chains that may be amenable to value-added or distribution-related facilities in the Tucson region.

Contents

List of Acronyms

Acronym	Description
ADOT	Arizona Department of Transportation
b.	Billions
BEA	Bureau of Economic Analysis
CBP	County Business Patterns
CSA	Combined Statistical Area
DFR	Draft Final Report
FAF	Freight Analysis Framework
FHWA	Federal Highway Administration
HS	Harmonized System
LA	Los Angeles
m.	Millions
MSA	Metropolitan Statistical Area
NAFTA	North American Free Trade Agreement
NAICS	North American Industry Classification System
OD	Origin-Destination
RFQ	Request for Quotation
SCTG	Standard Classification of Transported Goods
STCC	Standard Transportation Commodity Code
TAZ	Traffic Analysis Zone
TTCA	Transportation and Trade Corridor Alliance
TREO	Tucson Regional Economic Opportunities
UK	United Kingdom
US	United States

1 Introduction

1.1 Background

Pima Association of Governments (PAG) is developing its Regional Freight Plan with an anticipated completion date in the fall of 2017. PAG has purchased a license through ADOT for 2013 Transearch commodity flow data and wishes to solicit support for assistance with understanding and interpreting the data. As stated in the RFQ, the primary objective is to: *"Validate and interpret TRANSEARCH freight data for Pima County to develop a commodity flow report in support of the PAG Regional Freight Plan."*

1.2 Key Questions

The key questions flow directly from the RFQ and serve as the foundation of the Work Plan:

- How do the Transearch data for the region align with other data sources and with PAG's existing analysis of the data? What discrepancies are there, and how can these be explained and corrected?
- What story do the data tell with regard to commodity flows in the Tucson area, and how do these observations fit into the larger narrative of freight flows and freight planning in Arizona as well as the broader economic context in the region?

1.3 Project Structure

The project was developed in four tasks.

Task 1 "Project Inception" served to better understand expectations and to discuss the proposed methodology, work plan, and schedule.

Task 2 "Independent Data Review involved conducting a full independent validation/review of the PAG's preliminary Transearch findings against the primary data.

Task 3 "Commodity Flow Study" entailed conducting a detailed analysis of the commodity flow patterns in the Tucson area to identify factors such as key industry and commodity flows, inbound versus outbound imbalances, pass-through freight, and key trade partners.

Task 4 "Draft and Final Study Report" involved incorporating PAG's comments and feedback on Working Papers 1 and 2 into a draft final report (DFR) and final report.

This report constitutes the DFR, an output of Task 4.

1.4 Methodology

In checking the validity of the PAG Transearch data (provided by IHS Global Insight), CPCS used Transearch data provided to the Arizona Department of Transportation by IHS Global Insight to support data analytics of the Arizona State Freight Plan, for which CPCS is the prime consultant. We also examined various publically available data sources, such as FAF4, Commodity Flow Survey, U.S. Census Bureau, U.S. Bureau of Economic Analysis, and other data sources. In general, our approach was to triangulate the various data sources. While CPCS has taken reasonable efforts to cross-check data sources where appropriate, CPCS cannot guarantee the accuracy of third-party data.

1.5 Structure of the Report

The second chapter of this report is an introduction to the data sources used in the report.

The third chapter is an analysis of commodity flows in Pima County, including outbound, inbound, and internal flows, drawing attention to key commodities, destinations, and modes.

The fourth chapter is a benchmarking analysis of Tucson (Pima County), compared with other Arizona counties, 30 similar-sized metropolitan areas in the United States, and MAP Dashboard cities.

The fifth chapter focuses on regional economic goals and analyzes advanced product outflows as well as through-flows through the region. This is followed by a brief concluding chapter.

2 Introduction to Data

Key Chapter Takeaway

- The analysis in this paper relies largely on a Transearch dataset provided to PAG through a data purchase from IHS Global Insight by the Arizona Department of Transportation (ADOT) and associated findings developed as part of the study team's work on the Arizona State Freight Plan. Other data sources, such as Freight Analysis Framework (FAF), are used for data validation, a process described in Working Paper 1.
- The study team used an industry-based approach to compare flows of different commodities. Specifically, we aggregated commodities to the level of commodity groups, which align closely with specific industries.
- The area of analysis is **Pima County**. Freight flow linkages are studied with other counties in Arizona, other Bureau of Economic Analysis (BEA) zones in North America, and Canadian provinces/Mexican states.

2.1 Introduction to Data

2.1.1 Background

Transearch and similar commodity flow data sources serve as the foundation of most freight flow and related economic analyses. Pima Association of Governments (PAG) is developing its Regional Freight Plan with an anticipated completion date in the fall of 2017. PAG has purchased a license through ADOT for 2013 Transearch commodity flow data and wishes to solicit support for assistance with understanding and interpreting the data.

2.1.2 Description of Transearch Data

Transearch is the leading data source for national-level detailed commodity flows along with the FAF, which is more restrictive in terms of geographies and commodities. The strengths and weaknesses of both data sources have been discussed at length in other publications.[2]

Transearch is a proprietary dataset produced by IHS Global Insight using carrier origin-destination data as well as data collected from federal regulatory sources. It generally offers more detail than FAF, including with regard to commodity, sub-mode, and type of vehicle. It is also available at a finer level of geography, even the sub-county level, while FAF's lowest level of granularity is a sub-state zonal structure based on BEA regions.

2.1.3 Description of Geographies

The data for this study were provided to PAG through a data purchase from IHS by ADOT. The data were provided at a traffic analysis zone (TAZ) level, with the exception of rail data, which was provided at the BEA region level. The study team also received a supplementary updated Mexico-origin flows dataset from IHS Global Insight.

For the purpose of analyzing multimodal regional commodity flows in a consistent manner, we defined the study area as Pima County.[3] Unless otherwise specifically noted, in this study, "Tucson region," "Tucson area" and Pima County are defined as being coterminous.

The Transearch data show origin-destination (OD) flows for BEA zones, which are similar in principle to FAF zones or Census Combined Statistical Areas (CSAs) in that they are centered on large cities. BEA zones are the most expansive in that they include not only the suburbs but also considerable hinterlands, so as to ensure full coverage of the entire United States by these zones (i.e., no purely rural areas). Mexican origins and destinations are reflected in the Transearch data by states, and Canadian ODs by census metropolitan areas (CMAs).

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[2] A good reference is FDOT, "SWOT Analysis of TRANSEARCH and FAF Data." March, 2016.

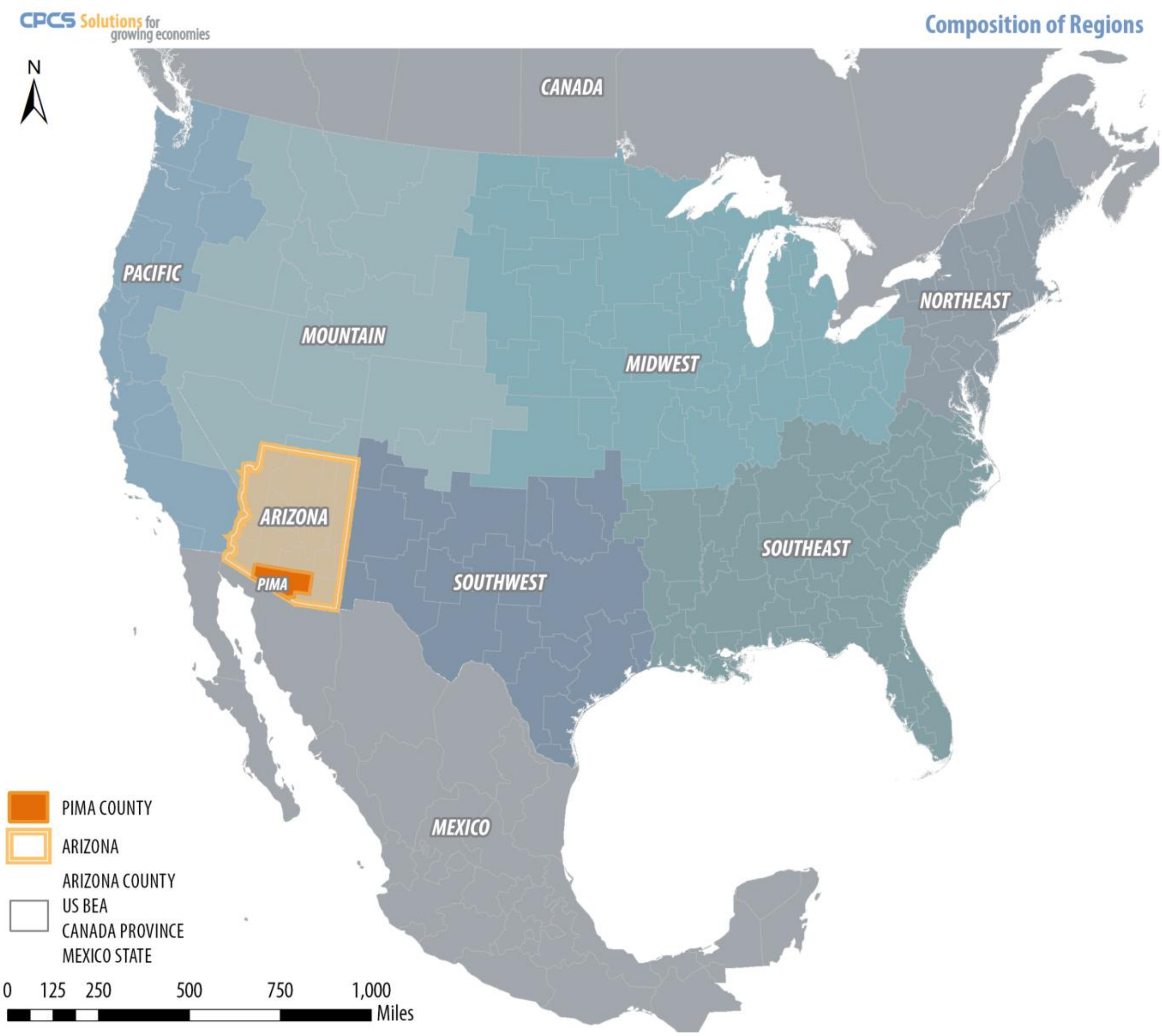
[3] Rail flows, including from the carload waybill sample, were available at the county level from the study team's work on the Arizona State Freight Plan. The study team double-checked the validity of these data compared to the dataset obtained through PAG. Because the ADOT data are at a finer level of aggregation (the county), these are the data that are used for this study.

We transformed these base zones as follows for the purpose of this study:

- For the state of Arizona, we show trading partner zones on the basis of **counties.**
- For elsewhere in the US, we show trading partner zones as **BEA zones.**
- For Mexico and Canada, we show trading partner zones as **states or provinces.**

We further group these geographies into nine regions, as shown in Figure 2-1.

Figure 2-1: Map of Regions and Trade Partner Zones



It should be noted that the origins and destinations of NAFTA flows are identified as the end location in Canada or Mexico. However, for overseas imports or exports, origins and destinations are identified in the Transearch data based on where they enter or exit the United States.

2.1.4 Description of Commodity Aggregation

We used an industry-based approach to compare flows of different commodities. Specifically, we aggregated commodities to the level of commodity groups, which align closely with specific industries. The purpose of this approach is manifold:

- It improves comparisons between different datasets, where commodities are defined differently. For example, while Transearch uses the rail-based Standard Transportation Commodity Codes (STCC), FAF uses Standard Classification of Transported Goods (SCTG) commodity codes, the U.S. Census Bureau border data Harmonized System (HS) commodity codes, and many types of employment and output data North American Industry Classification System (NAICS) industry codes. In Working Paper 1, we used some of these other datasets to check the validity of the Transearch data.
- It facilitates easier, more straightforward analysis and conclusions. With only 15 categories, it is easier to spot significant outliers.
- Defined in this manner, the commodity groups are more easily tied to specific industries and sectors, which can be tied to economic performance and goals.

We classified commodities as belonging to 15 primary categories (plus Other), listed in the table below. We further segmented these as Basic Products, Intermediate Products, and Advanced Products. The definitions are intended to be fairly broad, and the distinction refers to the complexity of the product rather than the complexity of manufacturing processes.

Figure 2-2: List of Commodity Groups

High-Level Group	Commodity Group
Basic Products	Agri-food Products
	Coal/Petroleum Products
	Metal Ores
	Nonmetallic Minerals
	Waste/Scrap
	Wood & Paper Products
Intermediate Products	Chemical Preparations
	Leather & Textile Products
	Metal Products
	Rubber & Plastic Products
Advanced Products	Electronics & Electrical Equipment
	Machinery
	Precision Instruments
	Transportation Equipment
Other	Other Manufactures
	Other

A more detailed table of definitions is located in Appendix A.

2.1.5 Quality Control

The study team performed an analysis of the Transearch data, expanding on issues initially identified by PAG, including cross-referencing the data to other sources such as the FAF.

One key issue that was identified relates to the outflow of space/missile vehicles from Tucson. The Transearch data indicated a total of $6.7 b. in internal flows of space vehicle/missile parts within a single traffic zone in Tucson. Based on review of Raytheon's annual report[4] as well as PAG feedback, it was determined that the $6.7 b. is likely in a reasonable range for missile flows. However, no foreign or domestic destinations are provided for these flows in the Transearch data, presumably because the missiles are handed over to the military and not classified as "freight" from that point on. Therefore, for a number of analyses in the study related to origin-destination flows, the missile flows are referenced in the footnotes but not included in charts.

Another issue that was identified was outflows from the Tucson region of motor vehicles, which totaled $7 b. Specifically, these were listed as rail outflows from the Tucson BEA region, which includes Santa Cruz County. We accessed county-level rail data from the consulting team's work on the Arizona State Freight Plan, which shows greater detail than the BEA-level data obtained from PAG. This dataset confirms that the $7 b. in rail flows originates in Santa Cruz County, and thus does not affect the outflows for Pima County. We also cross-referenced border data, which indicate that a similar magnitude of passenger cars is imported through the Nogales border point of entry.[5] The $7 b. appears to broadly align with the presumable value of 385,000 vehicles a year that are produced in Ford Motor Co.'s Hermosillo plant.[6]

Additional data validation was performed to reconcile an updated Mexico-related dataset received from Transearch with data used for ADOT's State Freight Plan.

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[4] Raytheon, Annual Reports & Proxy Statements, 2015 Annual Report.

[5] US Census Bureau, USA Trade Online.

[6] Gabriela Rico. "Ford's Hermosillo plant operating at maximum capacity." *Arizona Daily Star*. Jun 14, 2014.

3 Commodity Flows for Pima County

Key Chapter Takeaway

- On the basis of value, Transportation Equipment is the number one outflow from Pima County, likely associated predominantly with missile production by Raytheon.
- Other key outflows include Metal Ores (largely copper ores shipped to the refinery in Gila County), Precision Instruments (including optical instruments), and warehouse/distribution-related shipments.
- By tonnage, the major outflow is Non-metallic Minerals (including sand and gravel), which are shipped largely within Pima County and elsewhere in Arizona.
- Important inflows include fresh fruit and vegetables from Mexico, and finished products from warehouses/distribution centers in Maricopa County.
- Freight linkages are strongest with Maricopa County, as well as the Los Angeles area and the state of Sonora in Mexico. These linkages are most important for the Pima County freight economy. However, many exporters (including manufacturers of Advanced Products) also rely on customers all around the United States and overseas.

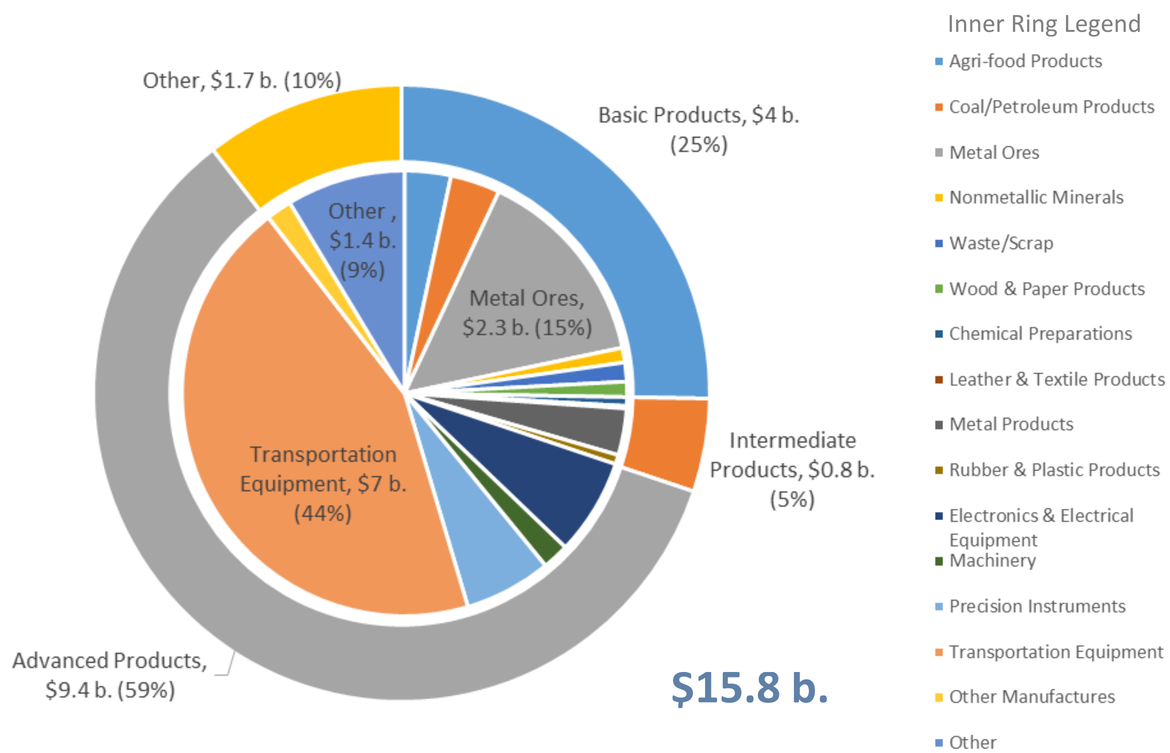
3.1 Outflows from Pima County

3.1.1 Domestic Outflows by Commodity

Domestic outflows from Pima County are shown in Figure 3-1. This includes all multimodal flows originating in Pima County, except internal flows (i.e., within Pima County).

The outer ring displays the four high-level commodity categories. The legend on the right-hand side shows the commodities in greater detail (these correspond to the inner ring, clockwise from the top). In other words, the inner ring shows a more detailed breakdown of the outer ring.

Figure 3-1: Domestic Outflows from Pima County (by Value)



Source: CPCS analysis of Transearch (2013)

In 2013, total domestic outflows totaled $15.8 b., with 25% of those being Basic Products, 5% Intermediate Products, and 59% Advanced Products. The largest commodity groups for domestic outflows were as follows:

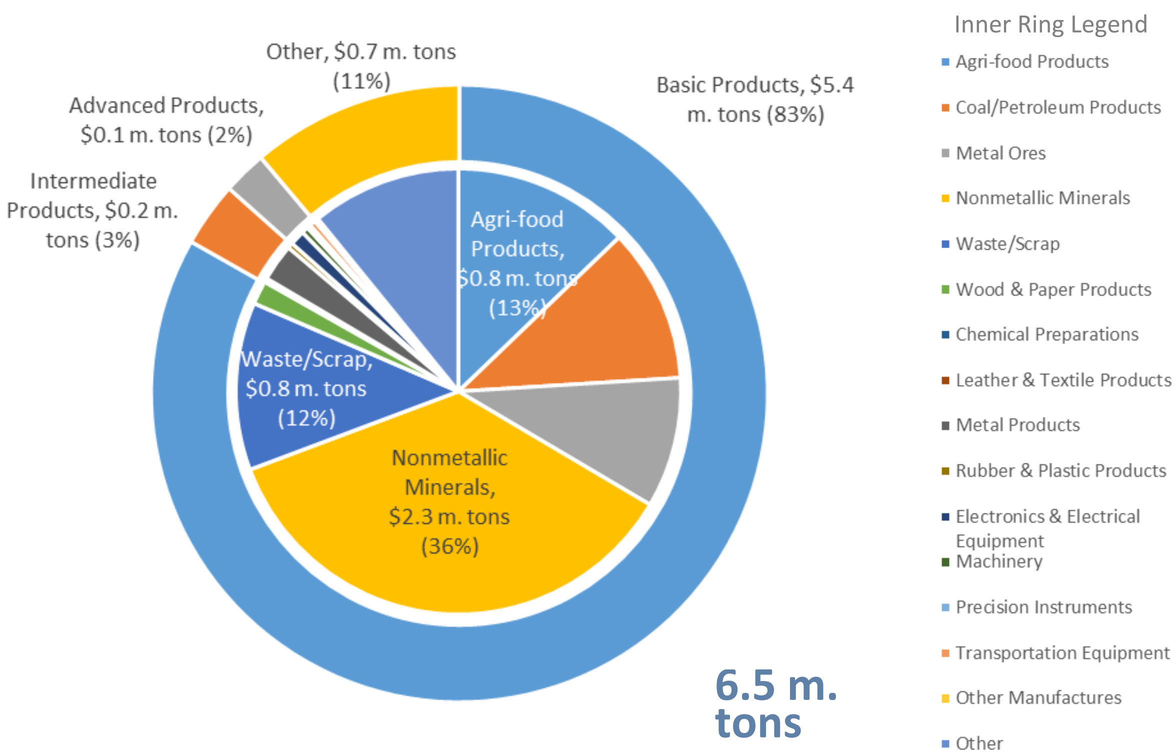
- $7.0 b. in Transportation Equipment, including $6.7 b. in missile and space vehicles (including parts)
- $2.3 b. in Metal Ores, including $1.7 b. in copper ores
- $1.1 b. in Electronics & Electrical Equipment of various kinds

- $1.0 b. in Precision Instruments, most (82%) of which is classified as engineering, laboratory or scientific equipment or instruments, and photographic or optical equipment

- $1.4 b. in Other, including $806 m. of warehouse and distribution center shipments

Assessed on the basis of tonnage rather than value, outflows from Pima County are dominated by Basic Products (83%), as shown in Figure 3-2. The top commodity groups by tonnage are Nonmetallic Minerals (36%), Agri-food Products (13%, including notably soft drinks and dairy farm products), Waste/Scrap (12%), and Coal/Petroleum Products (11%), as well as the Other category (11%, largely warehouse/distribution center shipments).

Figure 3-2: Domestic Outflows from Pima County (by Tonnage)



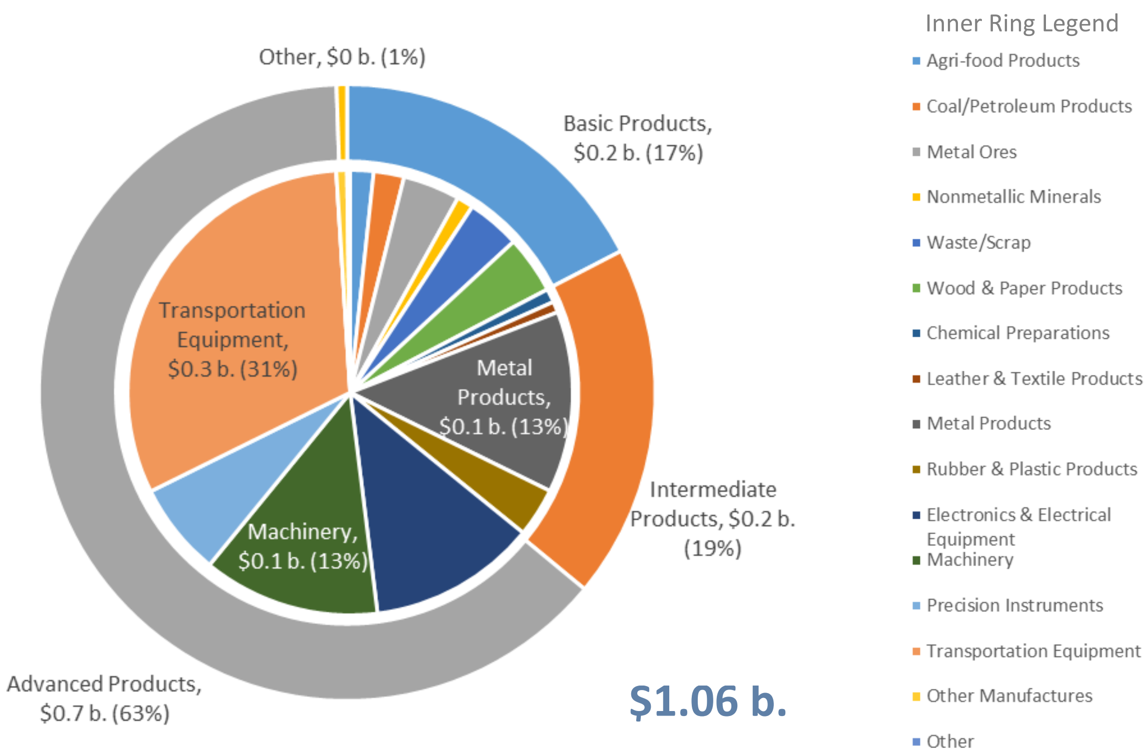
Source: CPCS analysis of Transearch (2013)

3.1.2 Exports by Commodity

Exports from Pima County are shown in Figure 3-3. This includes NAFTA exports to Mexico and Canada as well as shipments to elsewhere in the United States destined for export overseas.

Total exports originating in Pima County stood at $1.06 b. as of 2013. These were dominated by Advanced Products (63%). The largest commodity categories for exports were Transportation Equipment ($333 m., including $298 m. in aircraft), $140 m. in Metal Products, $136 m. in machinery, and $129 m. in Electronics & Electrical Equipment.

Figure 3-3: Exports from Pima County (by Value)

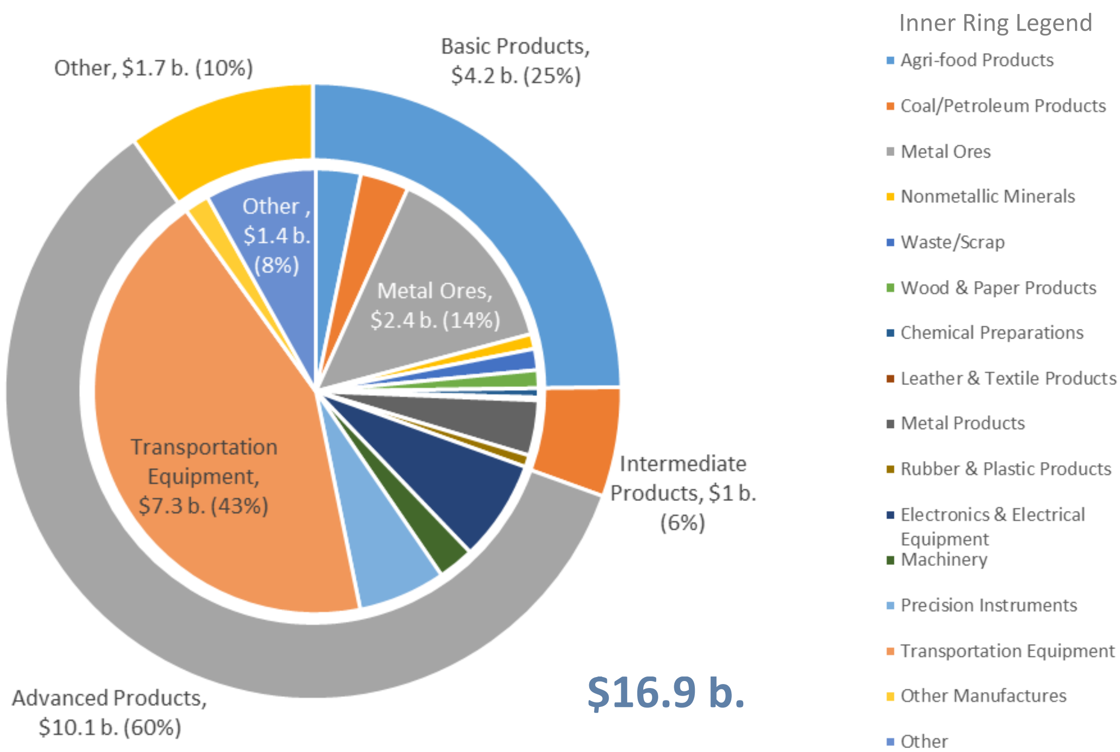


Source: CPCS analysis of Transearch (2013). Note: does not include any missile outflows, as these are included in Domestic.

3.1.3 Total Outflows

Figure 3-4 combines the previous two figures to show all outflows (domestic and exports). The top commodity categories by value are Transportation Equipment (43%), Metal Ores (14%), Other (8%), Electronics & Electrical Equipment (7%), and Precision Instruments (6%).

Figure 3-4: Total Outflows from Pima County (by Value)



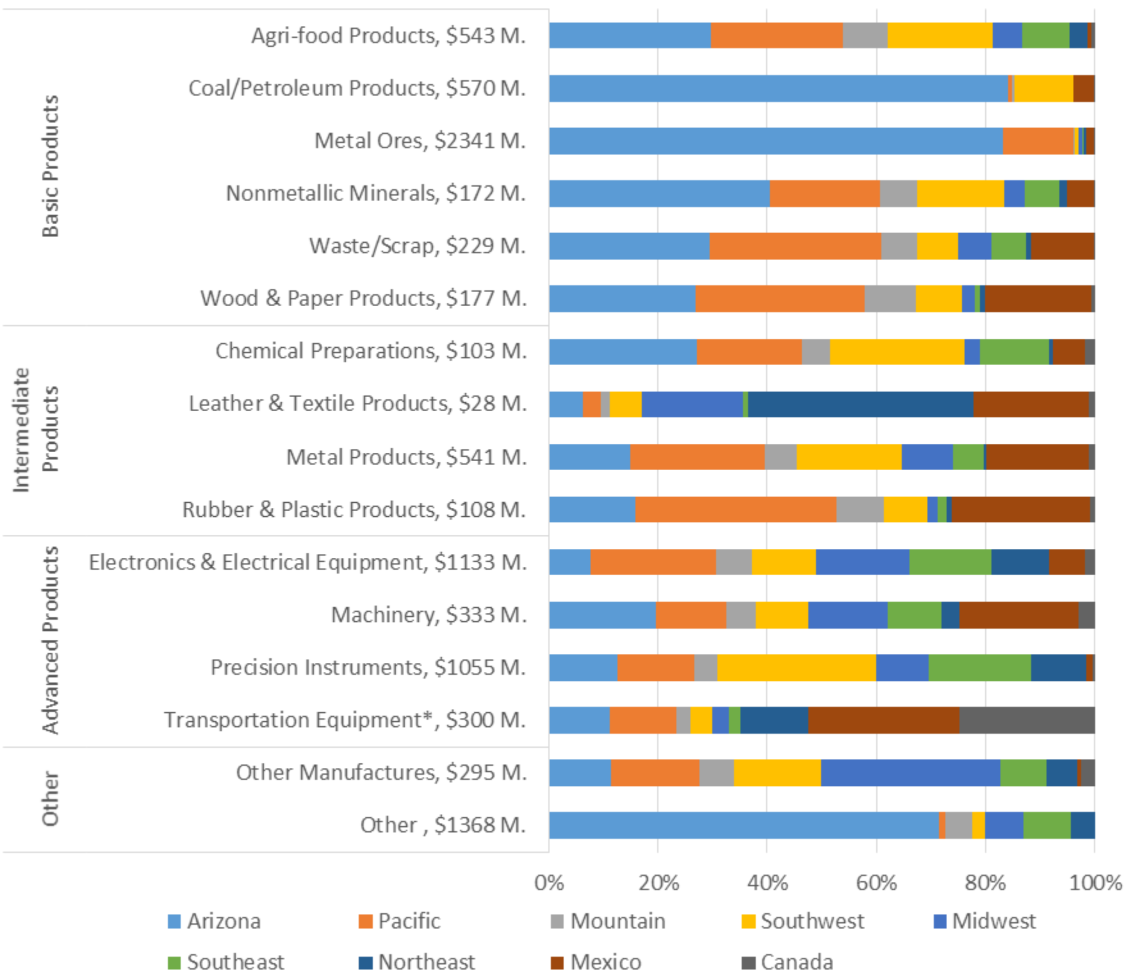
Source: CPCS analysis of Transearch (2013)

3.1.4 Domestic and NAFTA Destinations

Figure 3-5 shows the destinations for Pima County outflows, segmented by commodity group. This includes domestic and NAFTA destinations but does not include shipments within Pima County. Nor does it identify overseas destinations of exports (these are tagged to their domestic destination).

Not surprisingly, supply chains for Basic Products are highly local/regional, with a dominant percentage of flows destined for elsewhere in Arizona or nearby states. Intermediate Products, too, tend to be destined for Arizona, Mexico, or states in the U.S. Pacific or Southwest. Leather and Textile Products is an exception, but the total volume of flows is very low.

Figure 3-5: Destinations By Commodity for Outbound Flows from Pima County (by Value)



Source: CPCS analysis of Transearch (2013). *does not include $6.7 b. in missile/space vehicle parts (destination not identifiable through Transearch)

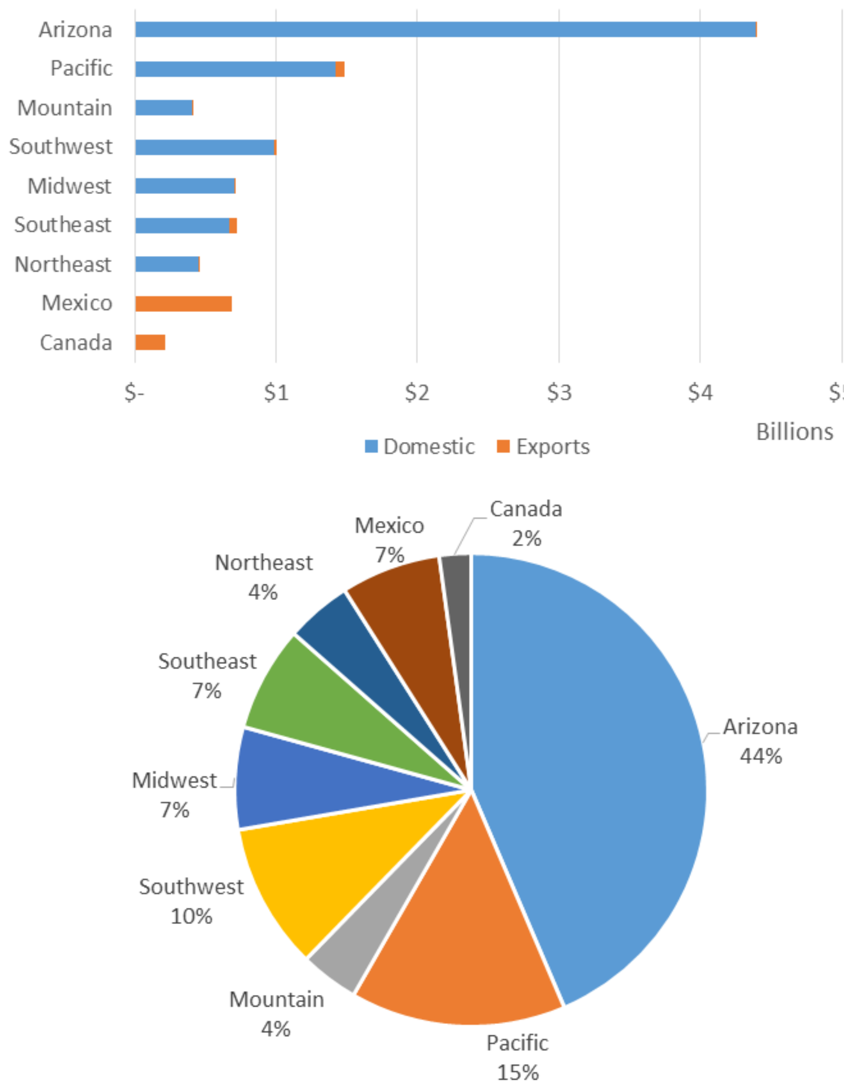
Advanced Products are shipped across the United States and North America, with more of a geographic balance in destinations. Shippers in this commodity group are transporting highly specialized equipment to businesses across the continent and world.

The Other category largely consists of warehouse and distribution center activity and serves predominantly other destinations in-state, including Maricopa, Pinal, Yavapai, and Coconino Counties.

Caution should be exercised when interpreting destinations for Transportation Equipment. The graph does not include $6.7 b. in missile/space vehicle parts, which Transearch has identified as internal flows within Pima County but which the study team reclassified as domestic outflows. Since the domestic destination is not identified through Transearch, these data are missing from that particular commodity group in the chart.

Overall, $4.4 b., or 43%, of all outflows from Pima County are destined for in-state, as shown in Figure 3-6. The next most significant destinations are the Pacific region (15%), the Southwest (10%), and the Midwest (10%), followed by Mexico (7%).

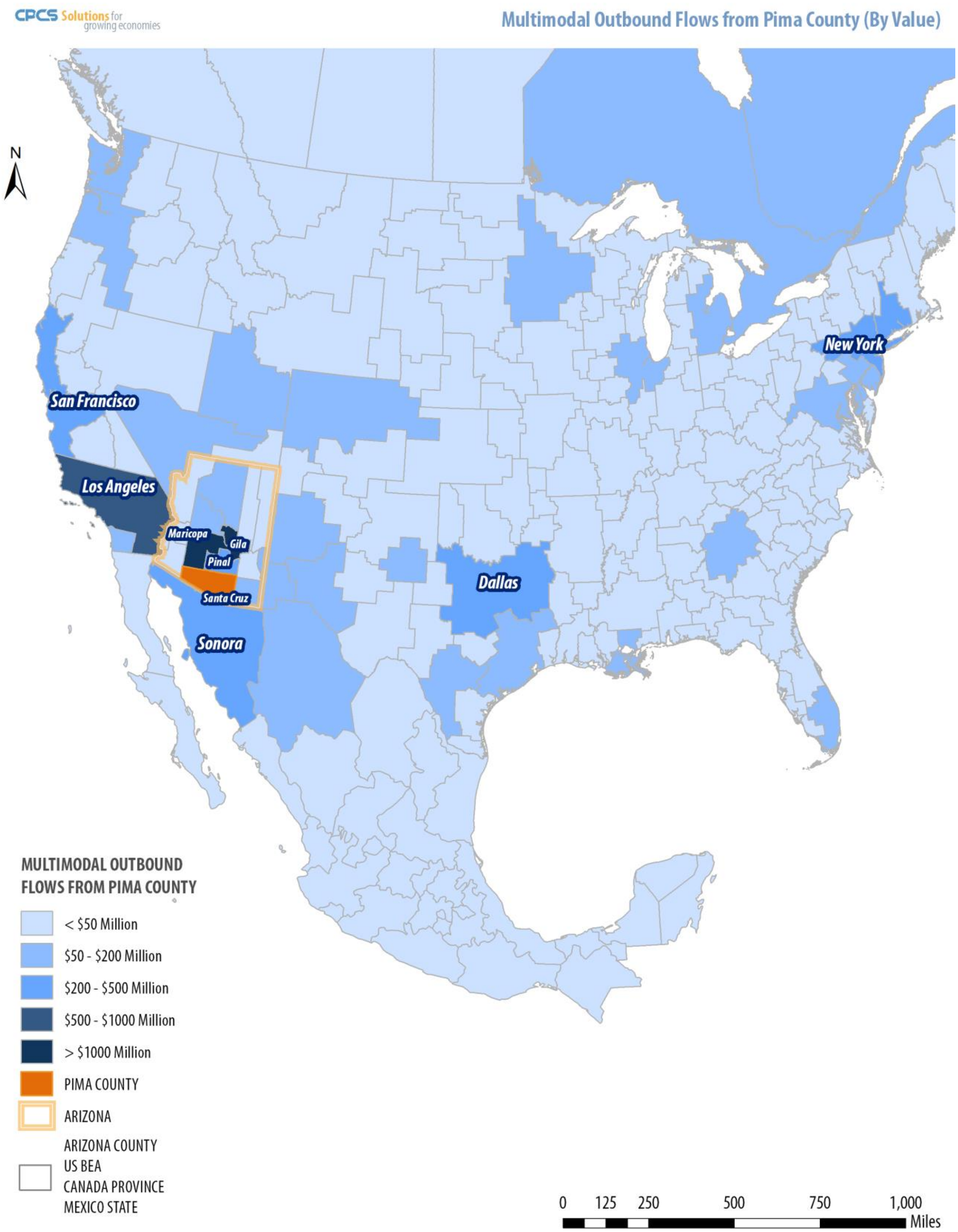
Figure 3-6: Destination Breakdown for All Outflows from Pima County (by Value)



Source: CPCS analysis of Transearch (2013). Does not include $6.7 b. in missile/space vehicle parts (destination not identifiable through Transearch).

Top destinations for outflows are mapped in Figure 3-7.

Figure 3-7: Top Destinations for Outflows from Pima County



Source: CPCS analysis of Transearch (2013).

Figure 3-8 displays the top five out-of-state destinations for each of the commodity groups, for outflows from Pima County. The Los Angeles BEA[7] (denoted LA) and the Mexican state of Sonora are the top destinations for most basic and Intermediate Products.

Figure 3-8: Top Five Out-of-State Destinations, by Commodity Group (by Value)

Commodity	# 1 Dest.	#2 Dest.	#3 Dest.	#4 Dest.	#5 Dest.
Agri-food Products	Los Angeles, CA ($69 m.)	El Paso, TX ($26 m.)	San Francisco, CA ($22 m.)	San Diego, CA ($16 m.)	Albuquerque, NM ($16 m.)
Coal/Petroleum Products	Phoenix, AZ ($62 m.)	Distrito Federal ($11 m.)	Sonora ($7 m.)	Los Angeles, CA ($3 m.)	Jalisco ($2 m.)
Metal Ores	Los Angeles, CA ($287 m.)	Sonora ($35 m.)	San Diego, CA ($9 m.)	Phoenix, AZ ($8 m.)	Houston, TX ($4 m.)
Nonmetallic Minerals	Los Angeles, CA ($24 m.)	El Paso, TX ($10 m.)	Sonora ($8 m.)	San Diego, CA ($5 m.)	Las Vegas, NV ($4 m.)
Waste/Scrap	Los Angeles, CA ($70 m.)	Sonora ($27 m.)	Lexington, KY ($10 m.)	Detroit, MI ($8 m.)	Las Vegas, NV ($7 m.)
Wood & Paper Products	Sonora ($35 m.)	Los Angeles, CA ($31 m.)	San Francisco, CA ($15 m.)	San Diego, CA ($12 m.)	Las Vegas, NV ($10 m.)
Chemical Preparations	Houston, TX ($15 m.)	Los Angeles, CA ($10 m.)	New Orleans, LA ($9 m.)	Sonora ($5 m.)	Dallas, TX ($4 m.)
Leather & Textile Products	Buffalo, NY ($13 m.)	Sonora ($7 m.)	Chicago, IL ($6 m.)	Harrisburg, PA ($2 m.)	El Paso, TX ($2 m.)
Metal Products	Sonora ($90 m.)	Los Angeles, CA ($84 m.)	Dallas, TX ($39 m.)	Columbia, MO ($34 m.)	San Francisco, CA ($33 m.)
Rubber & Plastic Products	Sonora ($33 m.)	Los Angeles, CA ($27 m.)	San Francisco, CA ($9 m.)	Las Vegas, NV ($6 m.)	Sacramento, CA ($5 m.)
Electronics & Electrical Eq.	Seattle, WA ($78 m.)	San Francisco, CA ($75 m.)	Sonora ($74 m.)	Dallas, TX ($64 m.)	New York, NY ($63 m.)
Machinery	Sonora ($75 m.)	Chicago, IL ($43 m.)	Los Angeles, CA ($28 m.)	Houston, TX ($13 m.)	San Francisco, CA ($11 m.)
Precision Instruments	Los Angeles, CA ($104 m.)	Washington, DC ($64 m.)	Dallas, TX ($60 m.)	Detroit, MI ($58 m.)	San Antonio, TX ($57 m.)
Transportation Equipment	Chihuahua ($109 m.)	New York, NY ($74 m.)	Sonora ($61 m.)	Non-CMA, QC ($47 m.)	Seattle, WA ($44 m.)
Other Manufactures	Anchorage, AK ($118 m.)	Minneapolis, MN ($27 m.)	Los Angeles, CA ($16 m.)	Chicago, IL ($12 m.)	Dallas, TX ($11 m.)
Other	Chicago, IL ($47 m.)	New York, NY ($23 m.)	Memphis, TN ($22 m.)	Las Vegas, NV ($21 m.)	Orlando, FL ($17 m.)

Source: CPCS analysis of Transearch (2013). *Phoenix BEA outside of Arizona comprises Grant, Luna and Hidalgo Counties in New Mexico.

Note: Transportation Equipment does not include $6.7 b. in missile/space vehicle parts (destination not identifiable through Transearch)

[7] Comprises the counties of Los Angeles, Orange, Ventura, Santa Barbara, San Luis Obispo, Kern, San Bernardino, Riverside and Imperial in California. Does not include Yuma and La Paz Counties which are also defined as part of the Los Angeles BEA but for this analysis are classified as in-state.

For Advanced Products, the top destinations are more varied and include the Seattle BEA for Electronics & Electrical Equipment, Sonora for machinery, Los Angeles BEA for Precision Instruments, and Chihuahua for Transportation Equipment (does not include missiles/space vehicles, as explained previously).

Figure 3-9 shows the top three in-state destinations by commodity group. In-state flows are dominated by metal ore shipments, largely transportation of copper ore from mines to the refinery in Gila County. The second dominant in-state flow is that of Other products—largely warehouse and distribution center shipments—to Maricopa County. For most commodity groups, the top in-state destination county for outflows from Pima County is Maricopa County, which suggests an interlinkage between freight activity in and around Tucson and Phoenix.

Figure 3-9: Top Three In-State Destinations, by Commodity Group (by Value)

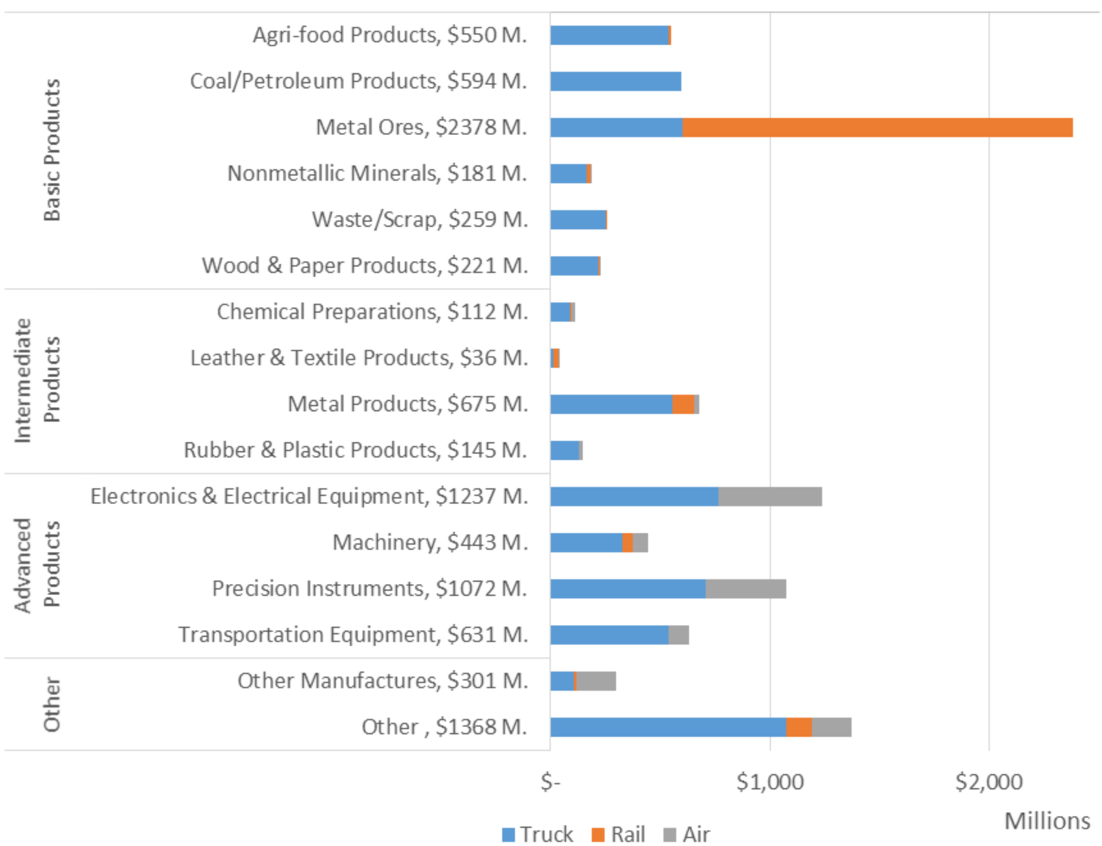
Commodity	# 1 Dest.	#2 Dest.	#3 Dest.
Agri-food Products	Maricopa ($95 m.)	Pinal ($36 m.)	Cochise ($10 m.)
Coal/Petroleum Products	Santa Cruz ($142 m.)	Greenlee ($120 m.)	Pinal ($112 m.)
Metal Ores	Gila ($1606 m.)	Santa Cruz ($171 m.)	Maricopa ($137 m.)
Nonmetallic Minerals	Maricopa ($36 m.)	Pinal ($19 m.)	Cochise ($7 m.)
Waste/Scrap	Maricopa ($33 m.)	Pinal ($17 m.)	Santa Cruz ($7 m.)
Wood & Paper Products	Maricopa ($46 m.)	Pinal ($4 m.)	Cochise ($2 m.)
Chemical Preparations	Maricopa ($28 m.)	Pinal ($1 m.)	Yavapai ($1 m.)
Leather & Textile Products	Maricopa ($2 m.)	Coconino ($0 m.)	Yavapai ($0 m.)
Metal Products	Maricopa ($86 m.)	Pinal ($5 m.)	Yavapai ($4 m.)
Rubber & Plastic Products	Maricopa ($19 m.)	Pinal ($1 m.)	Coconino ($1 m.)
Electronics & Electrical Eq.	Maricopa ($79 m.)	Coconino ($11 m.)	Yavapai ($3 m.)
Machinery	Pinal ($25 m.)	Greenlee ($19 m.)	Maricopa ($17 m.)
Precision Instruments	Maricopa ($107 m.)	Coconino ($17 m.)	Cochise ($5 m.)
Transportation Equipment	Maricopa ($68 m.)	Pinal ($1 m.)	Yavapai ($1 m.)
Other Manufactures	Maricopa ($19 m.)	Yavapai ($1 m.)	Pinal ($0 m.)
Other	Maricopa ($856 m.)	Pinal ($29 m.)	Yavapai ($22 m.)

Source: CPCS analysis of Transearch (2013).

3.1.5 Mode of Transportation for Outflows

Figure 3-10 shows the breakdown by mode for outflows from Pima County. Overall, 65% of outflows (by value) are by truck, 21% by rail, and 14% by air. If tonnage is considered (not shown), the breakdown is 92% by truck, 8% by rail, and under 1% by air. Truck tonnage is dominated by Nonmetallic Minerals, mostly sand/gravel destined for in-state, as well as Portland cement and concrete blocks destined for in-state as well asnearby destinations ranging from the Los Angeles area to West Texas (El Paso and Odessa).

Figure 3-10: Mode of Transportation for Outflows from Pima County (Bby Value)



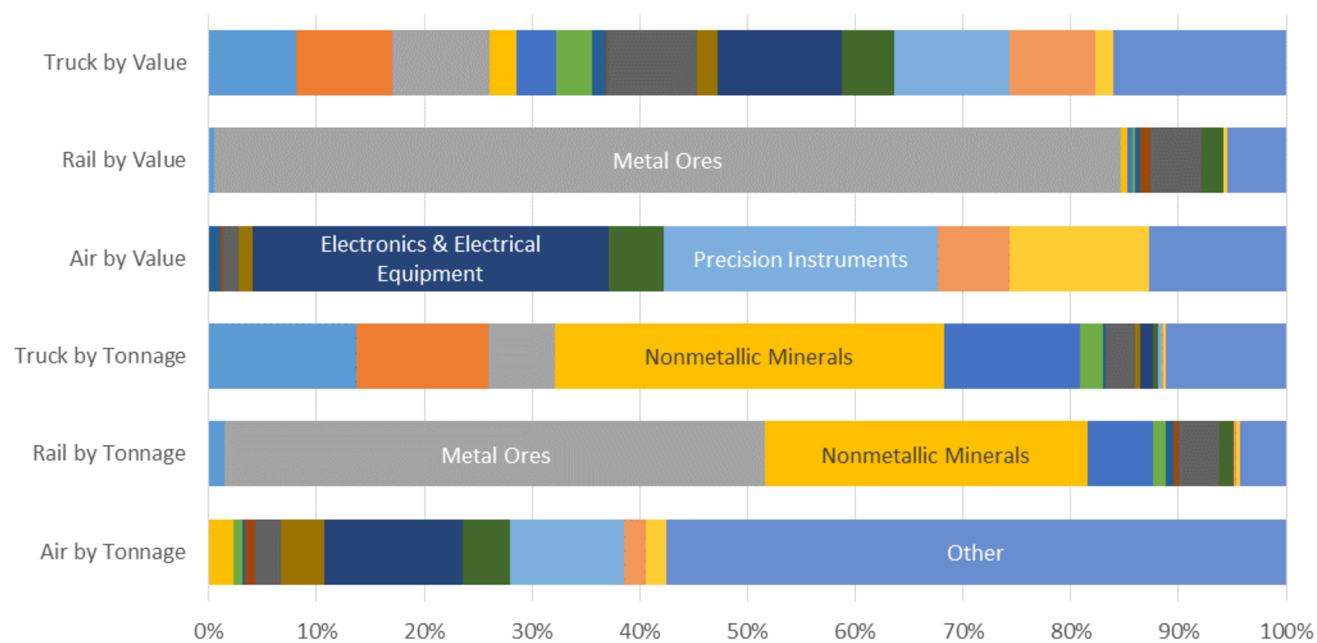
Source: CPCS analysis of Transearch (2013). Note: Transportation Equipment does not include $6.7 b. in missile/space vehicle parts (destination not identifiable through Transearch).

Figure 3-11 draws attention to the dominance of certain commodity groups among the different modes of transportation, for outflows from Pima County. Truck transportation is relatively balanced between commodity groups when measured by value; by tonnage Nonmetallic Minerals are more dominant.

Rail flows are dominated by Metal Ores in terms of value; by tonnage, Nonmetallic Minerals (in this case, Portland cement) are also important.

For air, the top commodity categories by value are Electronics & Electrical Equipment, and Precision Instruments. By tonnage, the Other category for air is largely small package shipments.

Figure 3-11: Commodity Breakdown by Mode, Outflows from Pima County (Value and Tonnage)



Source: CPCS analysis of Transearch (2013). Note: Transportation Equipment does not include $6.7 b. in missile/space vehicle parts (destination not identifiable through Transearch).

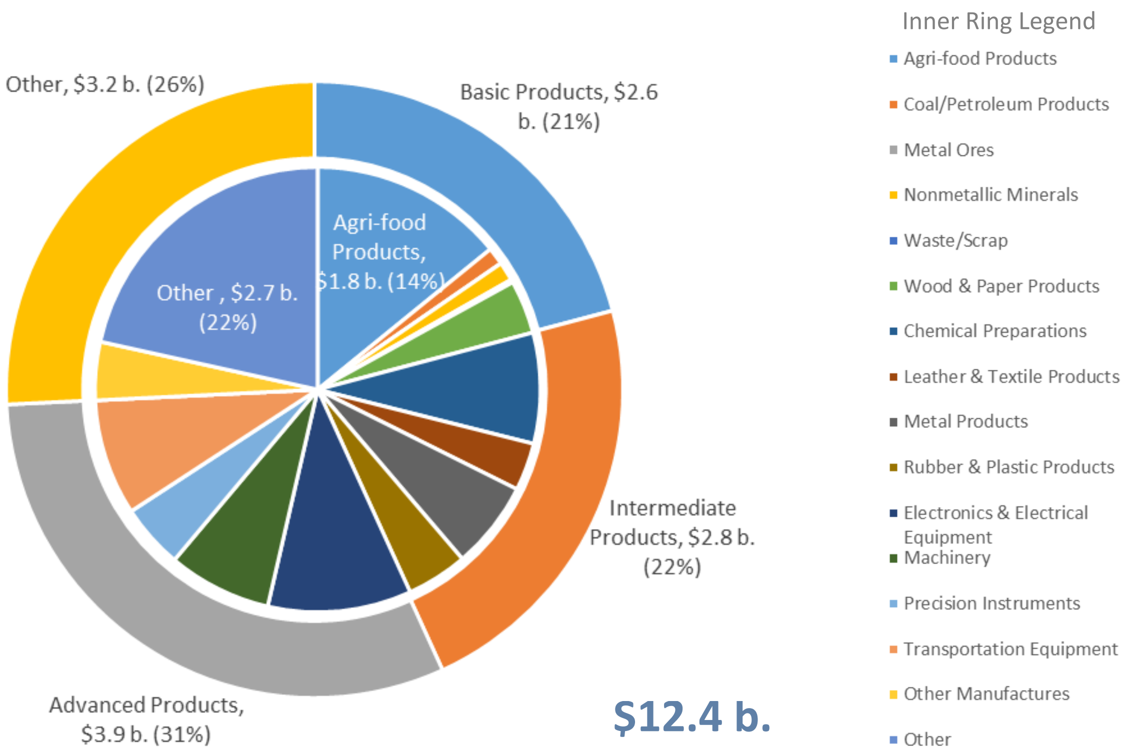
3.2 Inflows to Pima County

3.2.1 Domestic Inflows

Figure 3-12 shows the commodity distribution for domestic inflows to Pima County, by value. Total domestic inflows to Pima County stood at $12.4 b. in 2013. Compared with outflows, there is more of a balance between commodity groups. The top inflow categories are as follows:

- $2.7 b. in Other products, including $1.8 b. in warehouse and distribution center shipments
- $1.8 b. in Agri-food Products, mostly food products and beverages for final consumption
- $1.3 b. in Electronics & Electrical Equipment, including consumer products and industrial equipment
- $1.0 b. in Transportation Equipment, including $430 m. in motor vehicles
- $1.0 b. in Chemical Preparations, including $374 m. in drugs (pharmaceuticals)

Figure 3-12: Domestic Inflows to Pima County (by Value)

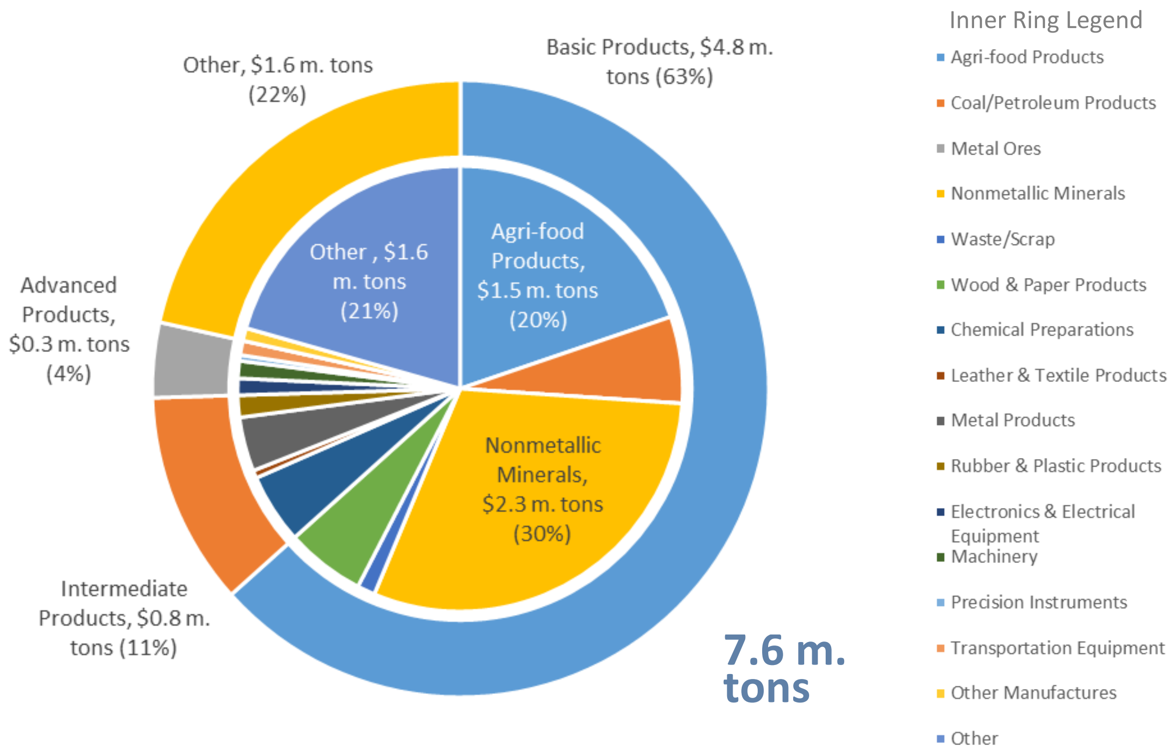


Source: CPCS analysis of Transearch (2013)

On the basis of tonnage, Basic Products are 63% of inflows into Pima County (Figure 3-13). This includes 30% Nonmetallic Minerals (mostly sand/gravel, broken stone/riprap, and ready-mix concrete) and 20% Agri-food Products (within which the top commodity is grain, at 17% of Agri-food Products).

The Other category consists mostly of warehouse and distribution center shipments.

Figure 3-13: Domestic Inflows to Pima County (by Tonnage)



Source: CPCS analysis of Transearch (2013)

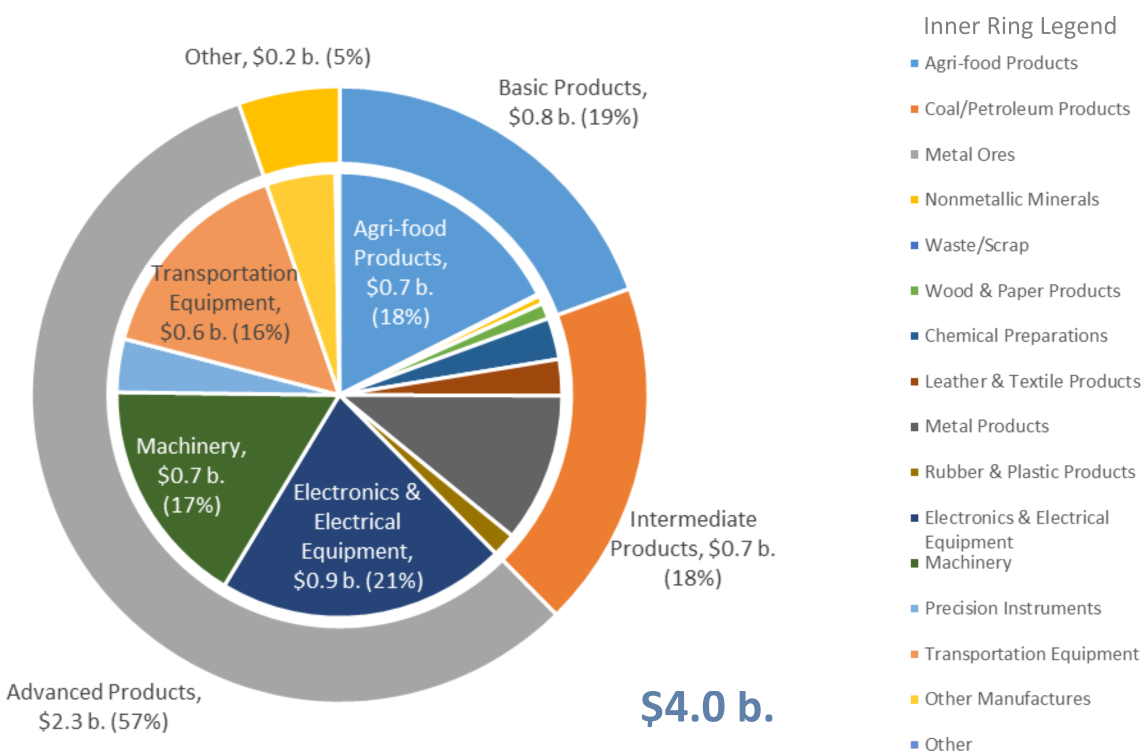
3.2.2 Imports by Commodity

Figure 3-14 shows imports to Pima County. This includes NAFTA imports from Mexico and Canada as well as imports from overseas routed through the other U.S. ports of entry.

Total imports destined to Pima County were $4.0 b. in 2013. As with exports, Advanced Products are over half of imports, at 57% ($2.3 b.). The top Advanced Products imported to Pima County were $850 m. in Electronics & Electrical Equipment, followed by $670 m. of Machinery and $630 m. of Transportation Equipment.

Also notable are $709 m. of Agri-food Products, which consist mostly of fresh fruit and vegetables imported from Mexico.

Figure 3-14: Import Inflows to Pima County (by Value)

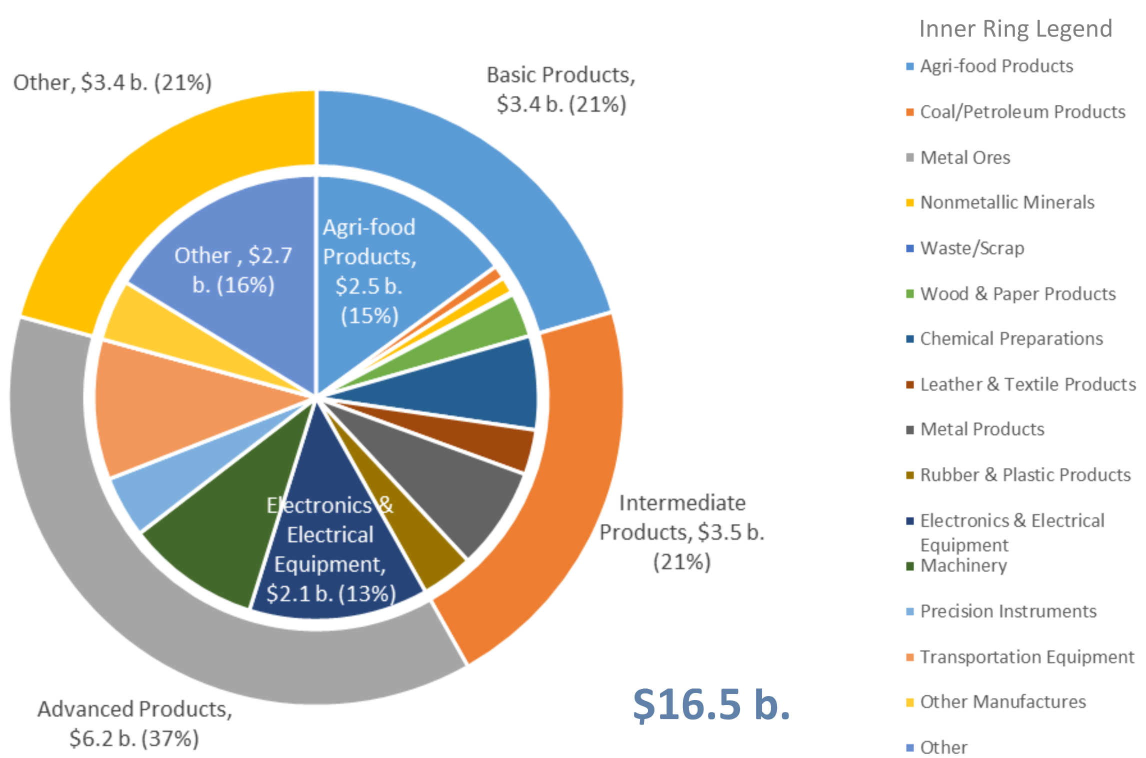


Source: CPCS analysis of Transearch (2013)

3.2.3 Total Inflows

Figure 3-15 consolidates the two previous figures to include both domestic inflows and imports. The top commodity groups for inflows are 16% Other (largely warehouse/distribution center shipments), 15% Agri-food Products, 13% Electronics & Electrical Equipment, 10% Transportation Equipment (including motor vehicles), and 10% MMachinery.

Figure 3-15: Total Inflows to Pima County (by Value)



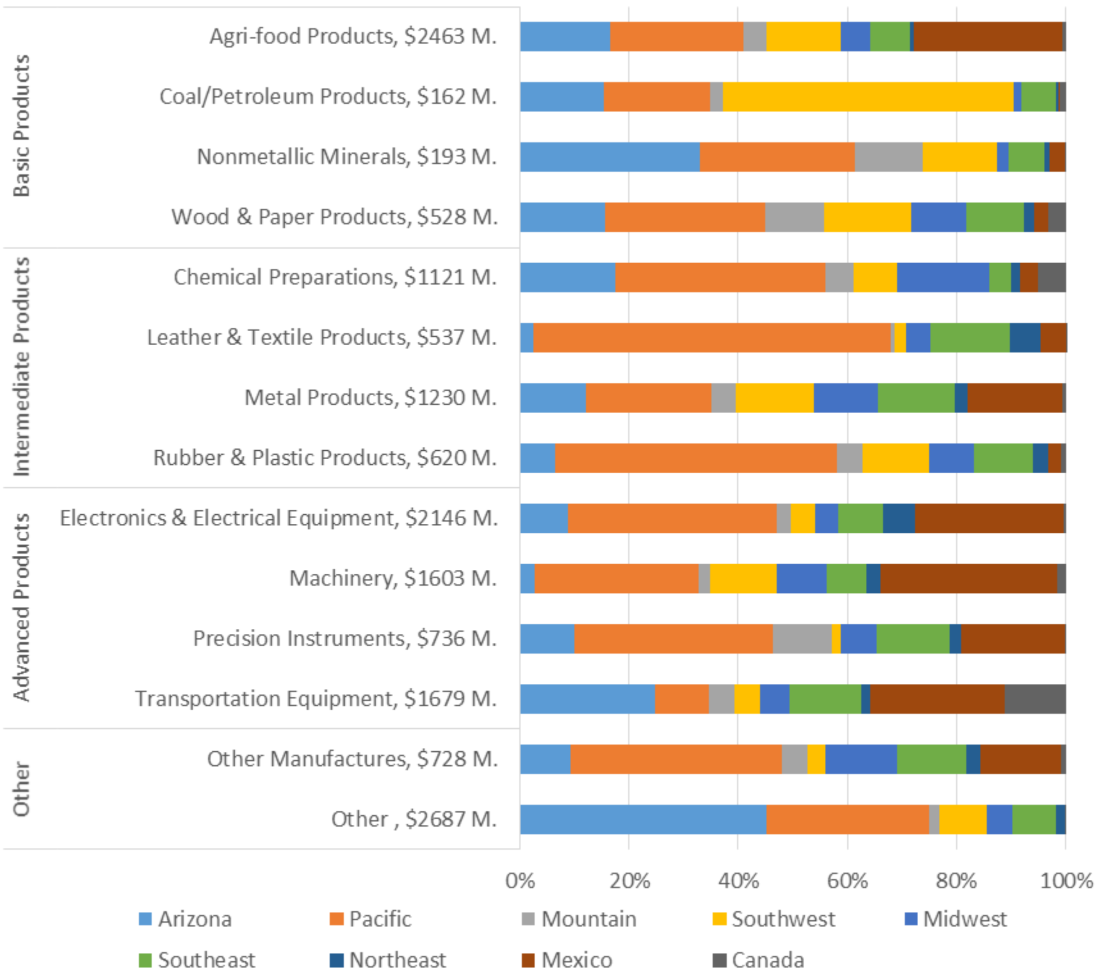
Source: CPCS analysis of Transearch (2013)

3.2.4

3.2.5 Domestic and NAFTA Origins

Figure 3-16 shows the origins of inflows to Pima County, segmented by commodity group. This includes domestic and NAFTA origins but does not include shipments within Pima County. Nor does it identify overseas origins of exports (these are tagged to their domestic origin). Metallic ores and Waste/Scrap are not shown due to the very low level of inflows of these commodities.

Figure 3-16: Origins By Commodity for Inbound Flows to Pima County (by Value)



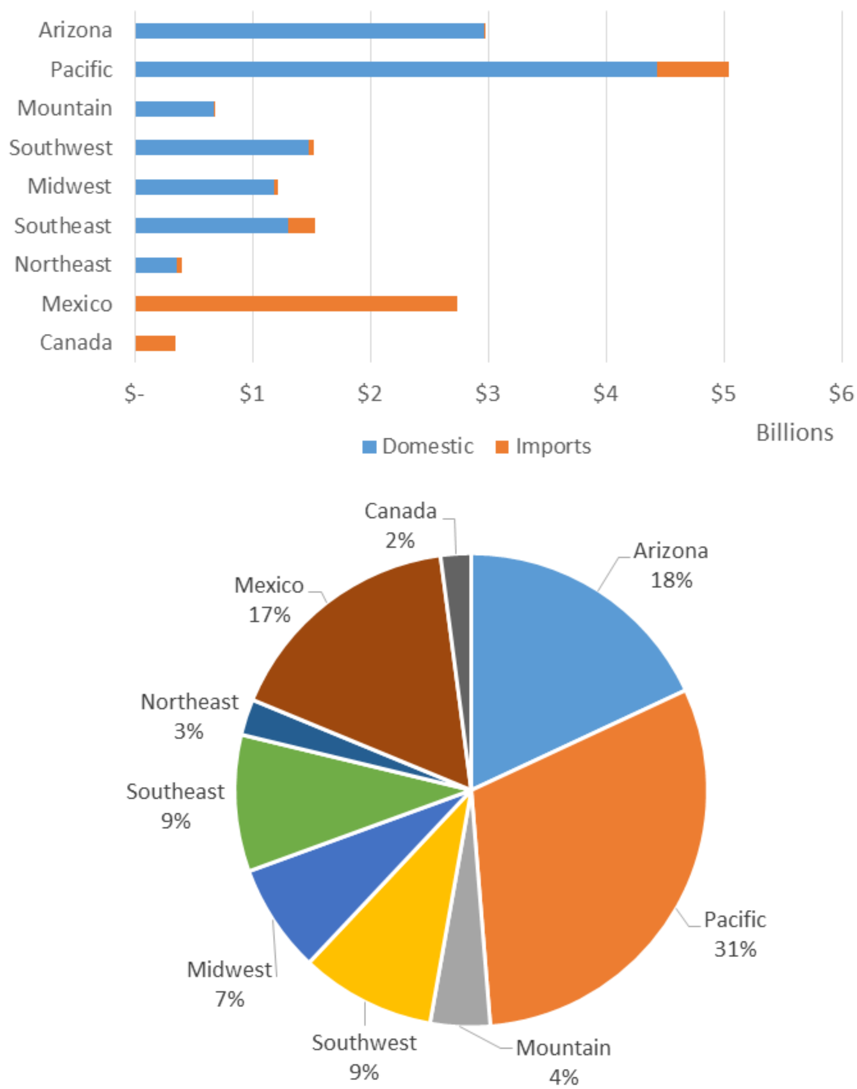
Source: CPCS analysis of Transearch (2013)

Overall, the Pacific region is an important origin region for almost all commodity groups. This is especially true of Leather and Textile Products (including apparel). Mexico is also an important origin region, particularly for Agri-food Products (fruits and vegetables) and Advanced Products (machines and equipment). The Southwest (including Texas) is an important origin for petroleum products. The rest of Arizona (including Phoenix) is important for inflows from distribution centers, reflected in the Other category. Relatively few products arrive from the Northeast, Southeast, or Canada.

Figure 3-17 displays the origin regions in greater depth, also distinguishing between imports and domestic shipments.

Overall, 31% of inflows to Pima County come from the Pacific region, notably California. (12% of flows from the Pacific are classified imports). Another 18% are from Arizona and 17% from Mexico. 12% of imports are from the Midwest and 9% from the Southwest.

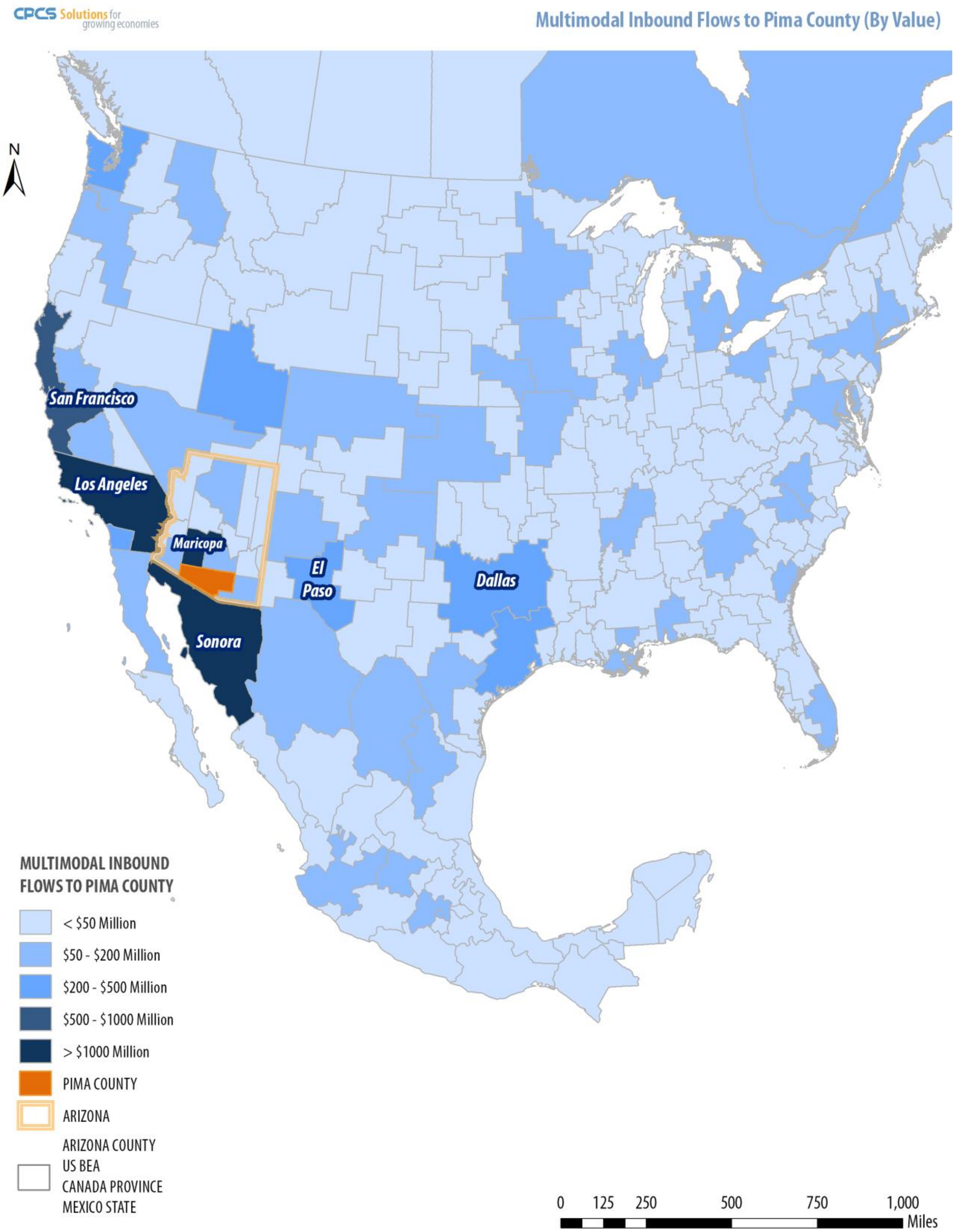
Figure 3-17: Origin Breakdown for all Inflows to Pima County (by Value)



Source: CPCS analysis of Transearch (2013).

Top origins for inflows are mapped in Figure 3-18.

Figure 3-18: Top Origins for Inflows to Pima County



Source: CPCS analysis of Transearch (2013)

Figure 3-19 displays the top five out-of-state origins for each of the commodity groups, for inflows to Pima County. The Los Angeles BEA (denoted LA) is the single most important origin for many commodity groups. Sonora also stands out as a top origin.

Figure 3-19: Top Five Out-of-State Origins, by Commodity Group (by Value)

Commodity	# 1 Dest.	#2 Dest.	#3 Dest.	#4 Dest.	#5 Dest.
Agri-food Products	Mexico Unkn. State ($570 m.)	Los Angeles, CA ($244 m.)	San Francisco, CA ($176 m.)	El Paso, TX ($80 m.)	Seattle, WA ($51 m.)
Coal/Petroleum Products	El Paso, TX ($58 m.)	Los Angeles, CA ($29 m.)	Houston, TX ($8 m.)	Tulsa, OK ($4 m.)	Beaumont, TX ($4 m.)
Metal Ores	Albuquerque, NM ($1 m.)				
Nonmetallic Minerals	Los Angeles, CA ($40 m.)	Las Vegas, NV ($15 m.)	Seattle, WA ($8 m.)	Dallas, TX ($6 m.)	Houston, TX ($6 m.)
Waste/Scrap	St. Louis, MO ($20 m.)	Lake Charles, LA ($3 m.)	Farmington, NM ($1 m.)	El Paso, TX ($1 m.)	
Wood & Paper Products	Los Angeles, CA ($84 m.)	Dallas, TX $28 m.)	Spokane, WA ($27 m.)	San Francisco, CA ($18 m.)	El Paso, TX ($15 m.)
Chemical Preparations	Los Angeles, CA ($227 m.)	San Diego, CA ($127 m.)	Des Moines, IA ($84 m.)	San Francisco, CA ($71 m.)	Dallas, TX ($45 m.)
Leather & Textile Products	Los Angeles, CA ($319 m.)	Savannah, GA ($31 m.)	New York, NY ($28 m.)	Chicago, IL ($20 m.)	Seattle, WA ($17 m.)
Metal Products	Los Angeles, CA ($210 m.)	Mobile, AL ($79 m.)	Sonora ($78 m.)	El Paso, TX ($59 m.)	New Orleans, LA ($50 m.)
Rubber & Plastic Products	Los Angeles, CA ($269 m.)	Dallas, TX ($26 m.)	San Francisco, CA ($19 m.)	Houston, TX ($15 m.)	San Diego, CA ($13 m.)
Electronics & Electrical Eq.	Los Angeles, CA ($465 m.)	Sonora ($293 m.)	San Francisco, CA ($133 m.)	New York, NY ($107 m.)	Seattle, WA ($92 m.)
Machinery	Los Angeles, CA ($372 m.)	Sonora ($195 m.)	Houston, TX ($88 m.)	Zaragoza ($62 m.)	Dallas, TX ($49 m.)
Precision Instruments	Los Angeles, CA ($172 m.)	Sonora ($70 m.)	Memphis, TN ($64 m.)	San Francisco, CA ($59 m.)	Denver, CO ($34 m.)
Transportation Equipment	Sonora ($262 m.)	Los Angeles, CA ($117 m.)	Memphis, TN ($92 m.)	Non-CMA, QC ($74 m.)	Salt Lake City, UT ($66 m.)
Other Manufactures	Los Angeles, CA ($204 m.)	Omaha, NE ($44 m.)	Mexico Unkn. State ($43 m.)	Portland, OR ($38 m.)	Sonora ($36 m.)
Other	Los Angeles, CA ($425 m.)	San Francisco, CA ($244 m.)	Charlotte, NC ($118 m.)	Albuquerque, NM ($56 m.)	Fresno, CA ($55 m.)

Source: CPCS analysis of Transearch (2013). Unkn = Unknown.

Figure 3-20 shows the top three in-state origins by commodity group. The most significant in-state flow is that of warehouse and distribution center shipments (the majority within the "other" category) from Maricopa County to Pima County. Although not highlighted in the graph, Maricopa County is the top origin for in-state freight flows to Pima County, ahead of other counties for almost all commodity groups. A similar pattern was seen for outflows from Pima County to Maricopa County, reinforcing the importance of freight linkages between these two counties.

Figure 3-20: Top Three In-State Origins, by Commodity Group (by Value)

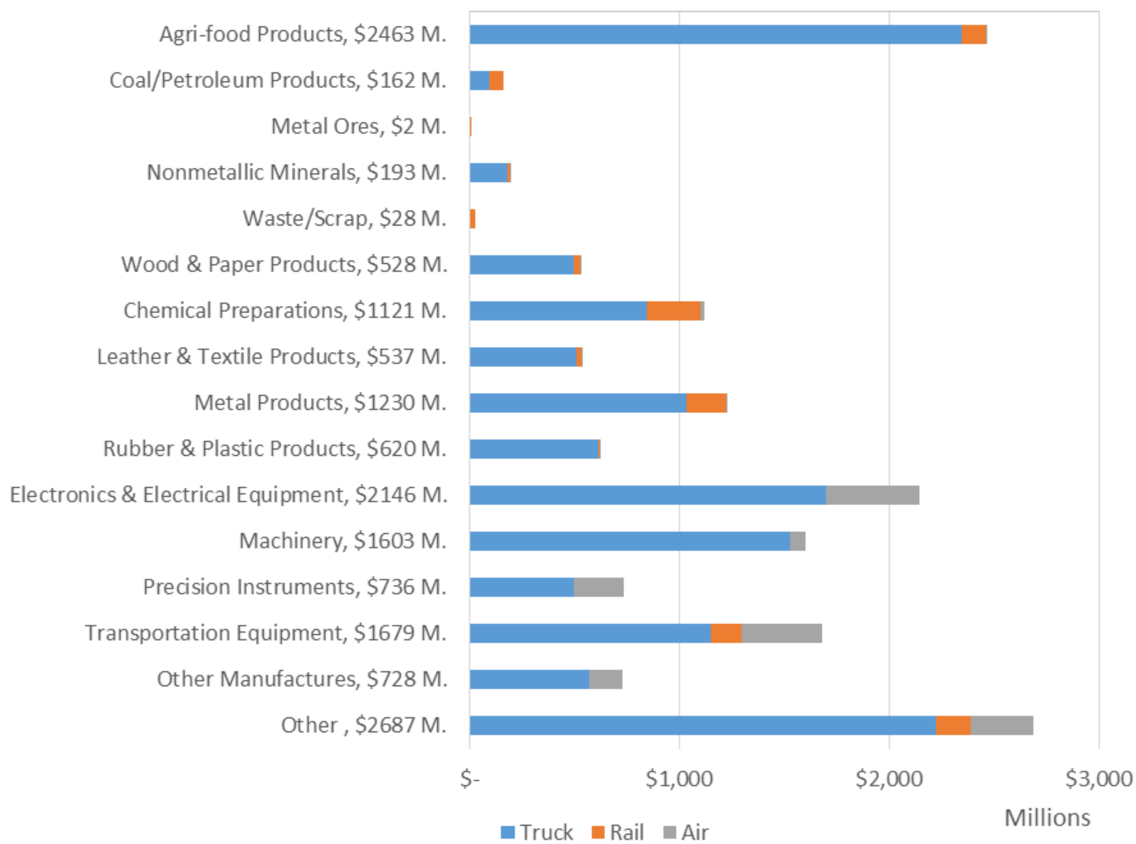
Commodity	# 1 Dest.	#2 Dest.	#3 Dest.
Agri-food Products	Maricopa ($205 m.)	Yuma ($68 m.)	Pinal ($68 m.)
Coal/Petroleum Products	Maricopa ($16 m.)	Pinal ($3 m.)	Apache ($3 m.)
Metal Ores	Cochise ($1 m.)		
Nonmetallic Minerals	Pinal ($20 m.)	Maricopa ($19 m.)	Cochise ($15 m.)
Waste/Scrap	Maricopa ($1 m.)		
Wood & Paper Products	Maricopa ($57 m.)	Navajo ($8 m.)	Mohave ($3 m.)
Chemical Preparations	Maricopa ($116 m.)	Santa Cruz ($57 m.)	Cochise ($13 m.)
Leather & Textile Products	Maricopa ($10 m.)	Yuma ($2 m.)	Mohave ($1 m.)
Metal Products	Maricopa ($131 m.)	Pinal ($10 m.)	Yavapai ($5 m.)
Rubber & Plastic Products	Maricopa ($29 m.)	Yavapai ($3 m.)	Mohave ($3 m.)
Electronics & Electrical Eq.	Maricopa ($176 m.)	Yavapai ($6 m.)	Coconino ($1 m.)
Machinery	Maricopa ($39 m.)	Santa Cruz ($2 m.)	Yuma ($1 m.)
Precision Instruments	Coconino ($37 m.)	Maricopa ($30 m.)	Santa Cruz ($2 m.)
Transportation Equipment	Maricopa ($411 m.)	Pinal ($1 m.)	Yavapai ($1 m.)
Other Manufactures	Maricopa ($58 m.)	Yavapai ($4 m.)	Santa Cruz ($3 m.)
Other	Maricopa ($1078 m.)	Coconino ($80 m.)	Yuma ($45 m.)

Source: CPCS analysis of Transearch (2013)

3.2.1 Mode of Transportation for Inflows

Figure 3-21 shows the breakdown by mode for inflows to Pima County. Overall, 84% of inflows to Pima County (by value) are by truck—which is a higher percentage than the outbound share of 65% by truck—while 6% are by rail, and 10% are by air. If tonnage is considered (not shown), the breakdown is 90% by truck, 10% by rail, and under 1% by air.

Figure 3-21: Mode of Transportation for Inflows to Pima County (by Value)



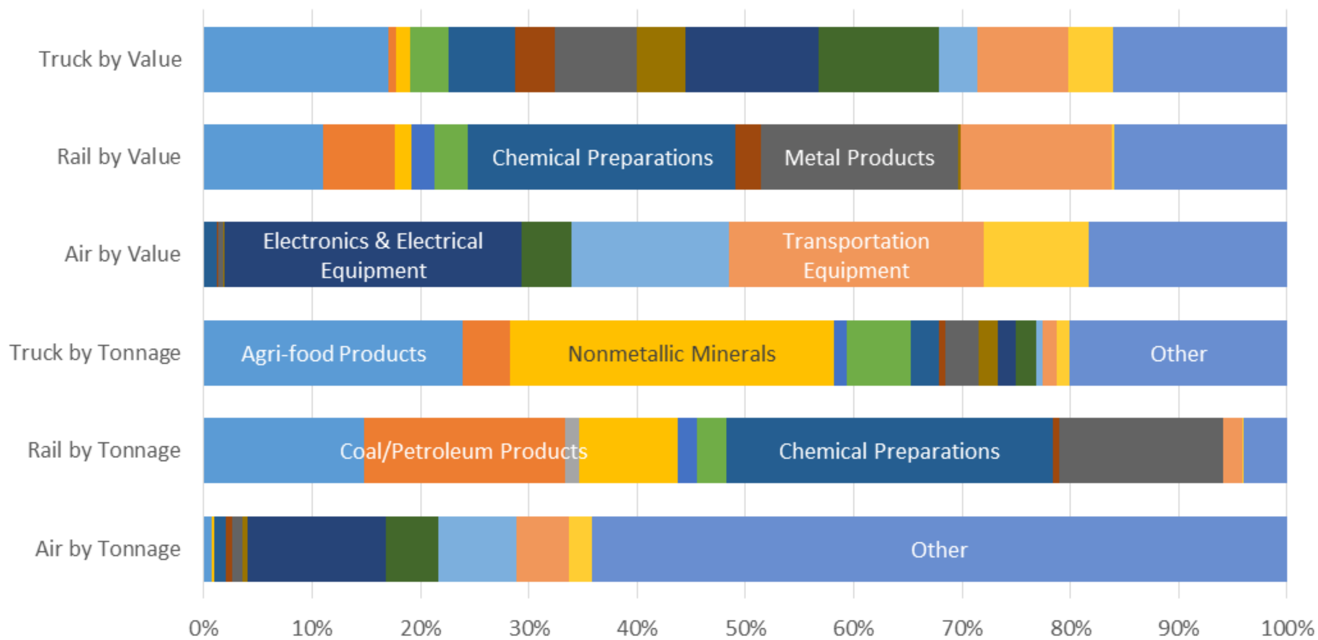
Source: CPCS analysis of Transearch (2013)

Figure 3-22 draws attention to the dominance of certain commodity groups among the different modes of transportation, for inflows to Pima County. Truck transportation is relatively balanced between commodity groups when measured by value; by tonnage, Nonmetallic Minerals are more dominant. This is a similar pattern as seen for outflows from Pima County.

The largest commodity groups for inbound rail flows are Chemical Preparations and Metal Products. Measured by tonnage, coal and petroleum products are also a significant share of rail inflows.

For air, the top commodity categories by value are Electronics & Electrical Equipment, and Transportation Equipment. By tonnage, the Other category for air is largely small package shipments.

Figure 3-22: Commodity Breakdown by Mode, Inflows to Pima County (Value and Tonnage)



Source: CPCS analysis of Transearch (2013).

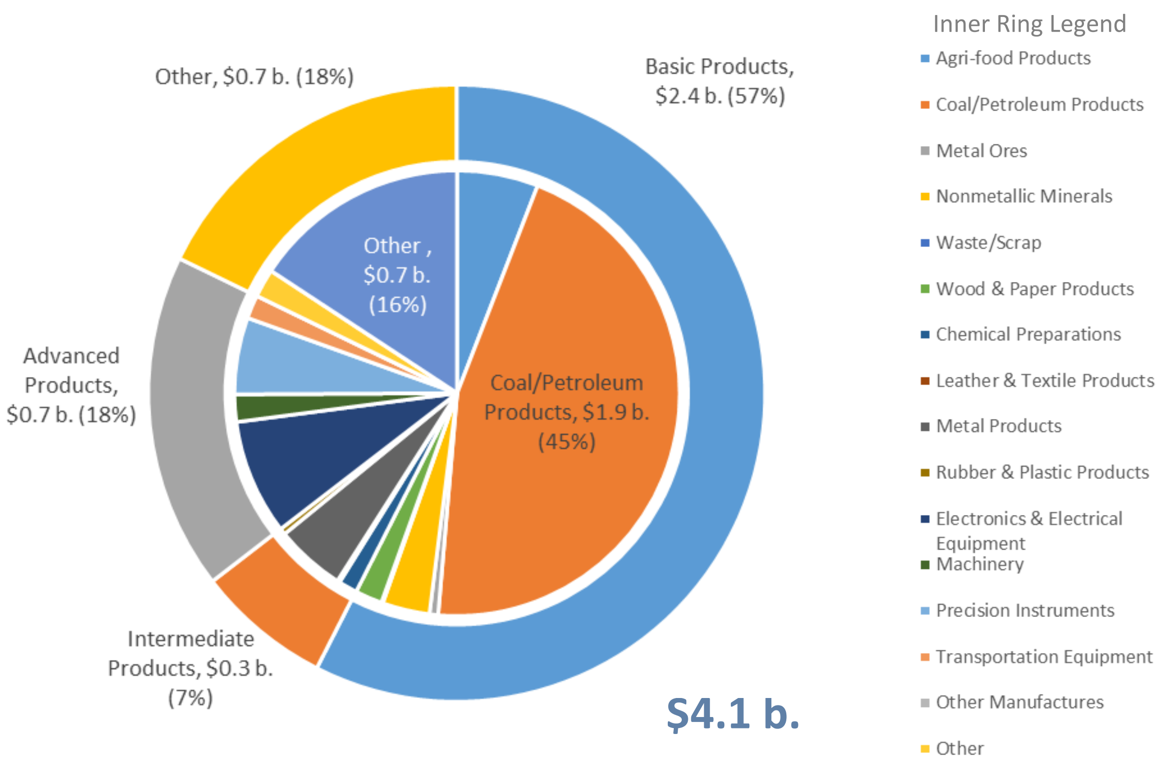
3.3 Internal Flows within Pima County

3.3.1 Commodity Breakdown

Figure 3-23 shows the breakdown by commodity group for freight flows internal to Pima County (i.e., within the region). On a value basis, the major commodity being shipped within the region is petroleum, which includes shipments from fuel depots and terminals to gas stations. The value of these shipments is $1.9 b. annually.

Also significant is the Other category. This includes $490 m. of rail intermodal drayage, $141 m. in warehouse and distribution center shipments, and $20 m. in air freight drayage.

Figure 3-23: Internal Flows within Pima County (by Value)



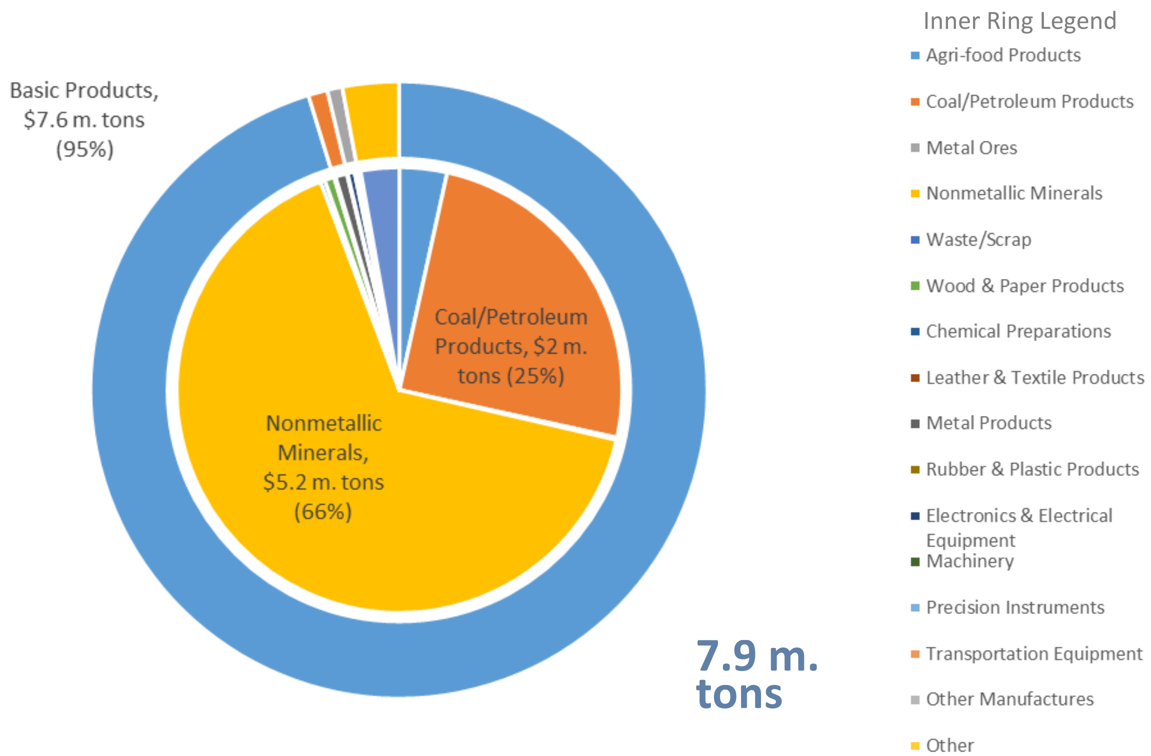
Source: CPCS analysis of Transearch (2013)

Figure 3-24 shows freight flows within Pima County on a tonnage basis. These freight flows are totally dominated by Basic Products, notably Nonmetallic Minerals and Coal/Petroleum Products.

Among Nonmetallic Minerals, 75% by tonnage is gravel and sand, 9% is ready-mix concrete, 6% is broken stone or riprap, 5% is concrete products, and 4% is Portland cement. Among Coal/Petroleum Products, 84% by tonnage is petroleum-refining products and 13% is asphalt paving blocks or mix.

The only other product with a similar magnitude in terms of tonnage is soft drinks/mineral water, within Agri-food Products.

Figure 3-24: Internal Flows within Pima County (by Tonnage)



Source: CPCS analysis of Transearch (2013)

4 Benchmarking Pima County

Key Chapter Takeaway

- Three benchmarking analyses were performed: first, a comparison of Pima County with other counties in Arizona; second, a comparison of the Tucson metropolitan area (i.e. Pima County) with other similar-sized metropolitan areas nationally; and third, a comparison of Tucson (Pima County) with other MAP Dashboard cities.
- Depending on data availability, the comparisons were done on the basis of freight generation and/or freight-related employment.
- Within Arizona, freight generation is dominated by Maricopa County, with Pima ranking second.
- Among similar-sized metropolitan areas in the United States, Tucson ranks among the bottom in terms of freight-related employment (construction, raw materials, manufacturing, transportation, and wholesale trade) as a percentage of total employment. Ranked in terms of payroll, Tucson ranks somewhat higher, driven by well above-average payroll per employee in manufacturing.
- FAF data show a similar picture, with Tucson ranked relatively low in terms of freight generation relative to similar FAF regions of similar population as well as relative to MAP Dashboard cities.

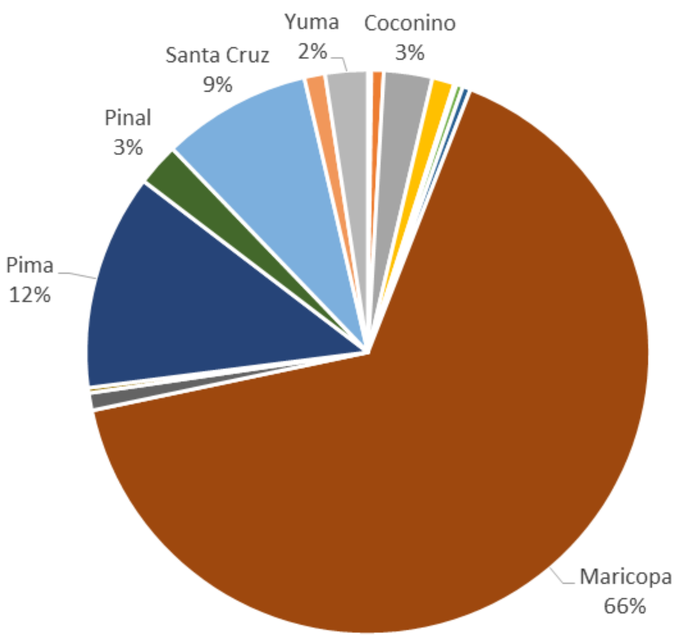
4.1 Comparison of Pima County to Other Counties in Arizona

4.1.1 Comparison of Arizona Counties by Freight Generation

The study team used the Transearch data to compare Pima County with other counties in Arizona, in terms of freight generation.

In 2013, a total of $143 b. of freight was generated in Arizona, of which 15% or $21 b. was generated in Pima County. Figure 4-1 shows the breakdown of freight generation by county. Maricopa County is responsible for 64% of freight generation, followed by Pima, Santa Cruz, Coconino, Pinal, and Yuma counties.

Figure 4-1: Annual Value of Freight Generated in Arizona, by County



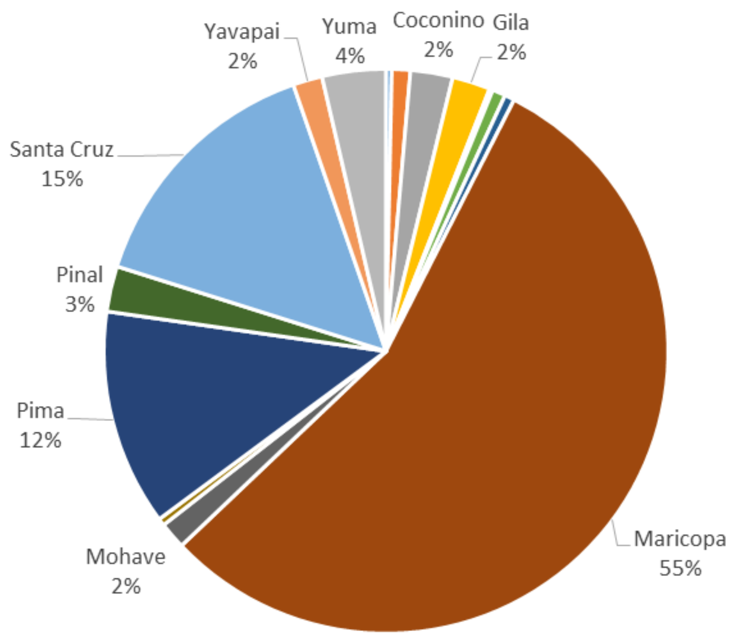
County	Value ($m.)
Apache	$ 274
Cochise	$ 987
Coconino	$ 3,868
Gila	$ 1,769
Graham	$ 195
Greenlee	$ 534
La Paz	$ 624
Maricopa	$ 91,586
Mohave	$ 1,386
Navajo	$ 418
Pima	**$ 17,244**
Pinal	$ 3,407
Santa Cruz	$ 11,911
Yavapai	$ 1,659
Yuma	$ 3,394

Source: CPCS analysis of Transearch data (2013)

Of the $143 b. of freight generated in Arizona in 2013, $75 B. remained in-state, i.e. was to in-state destinations.

Figure 4-2 shows a similar breakdown as the previous figure, except excluding in-state shipments. In other words, the graph and table show only the value of freight destined for out-of-state or to foreign destinations (exports). Maricopa County generates 58% of this freight, followed by Santa Cruz County at 15% and Pima County at 9%.

Figure 4-2: Annual Value of Freight Generated in Arizona, by County (Excluding In-State Freight)

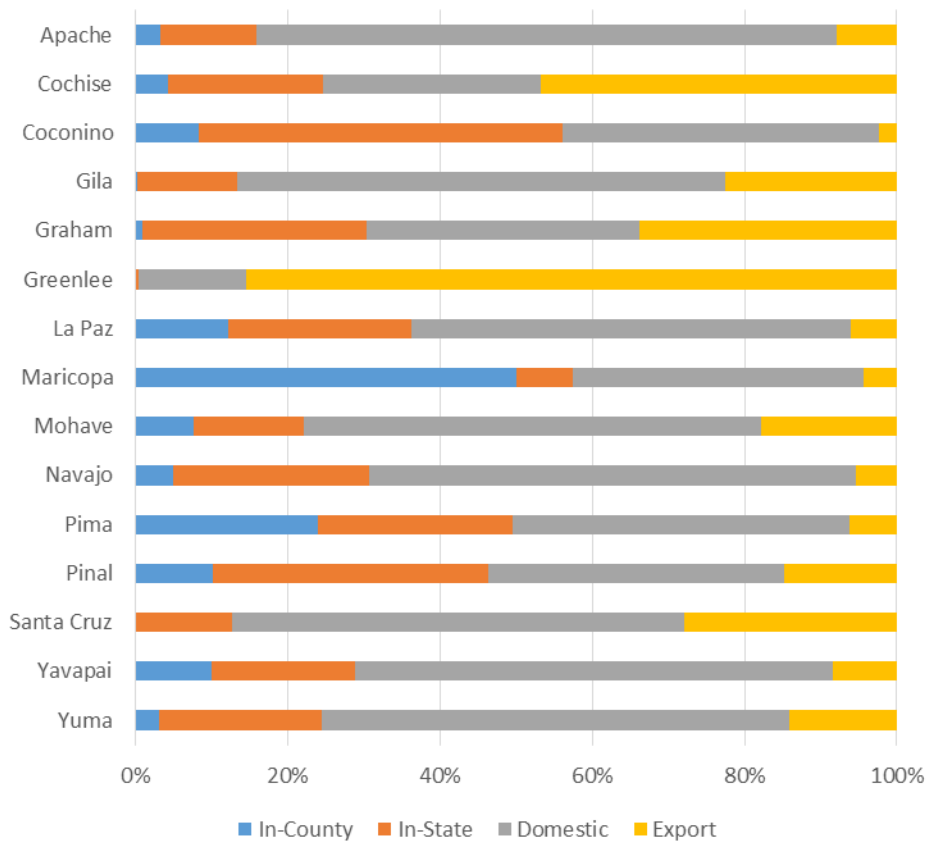


County	Value ($m.)
Apache	$ 230
Cochise	$ 744
Coconino	$ 1,698
Gila	$ 1,532
Graham	$ 135
Greenlee	$ 531
La Paz	$ 397
Maricopa	$ 38,907
Mohave	$ 1,080
Navajo	$ 290
Pima	**$ 8,707**
Pinal	$ 1,829
Santa Cruz	$ 10,397
Yavapai	$ 1,180
Yuma	$ 2,562

Source: CPCS analysis of Transearch data (2013)

Figure 4-3 shows the percentage breakdown at the county level. For each county, the graph shows the share of freight (by value) according to its destination. Like Maricopa County, Pima County has a high percentage of freight shipped in-county, which is not surprising given the high populations of these two counties.

Figure 4-3: Destination of Freight Generated in Arizona, by County



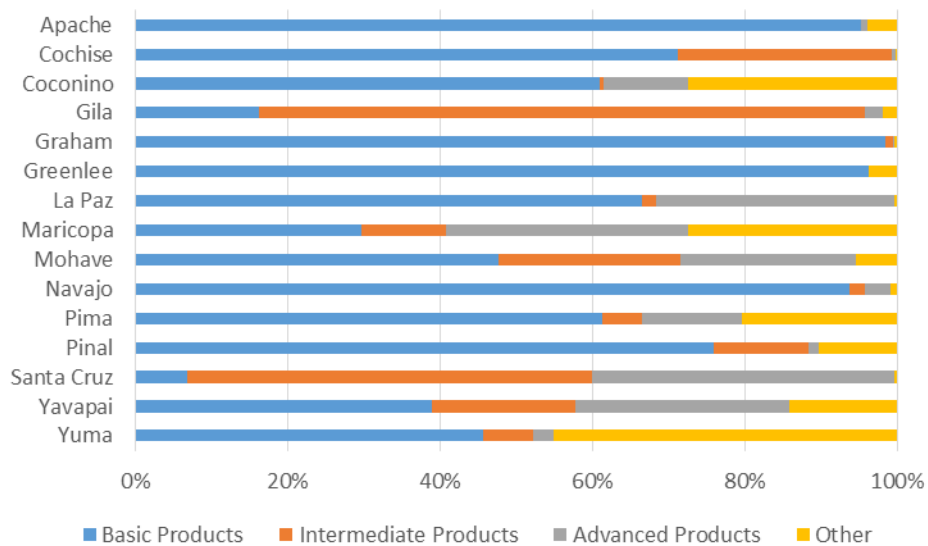
Source: CPCS analysis of Transearch data (2013)

shows the distribution by commodity group (basic, intermediate, advanced, and other), for in-state shipments; Figure 4-5 shows the same distribution for out-of-state shipments. Pima

County has a large percentage of Advanced Products among out-of-state shipments, similar to Maricopa and Coconino Counties (in the latter case, driven by surgical/medical instruments).

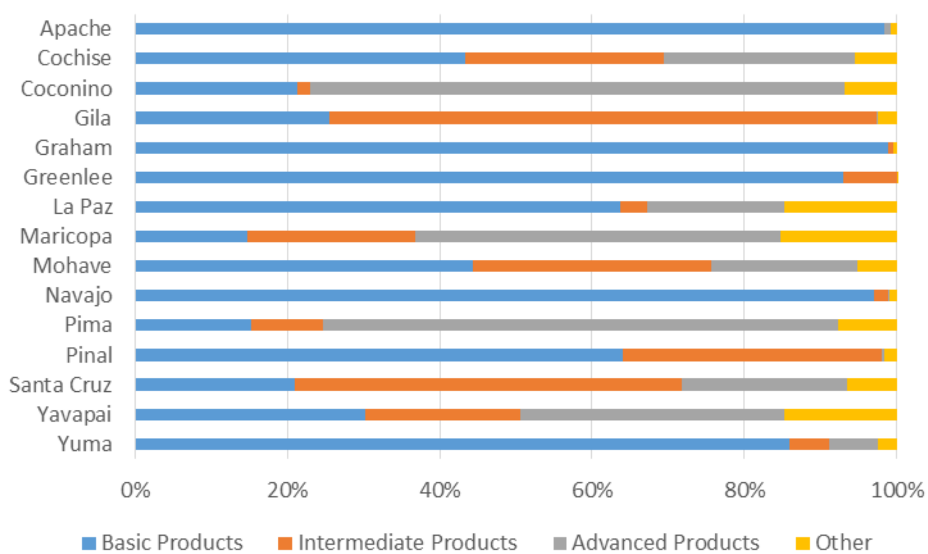
Figure 4-4 shows the distribution by commodity group (basic, intermediate, advanced, and other), for in-state shipments; Figure 4-5 shows the same distribution for out-of-state shipments. Pima County has a large percentage of Advanced Products among out-of-state shipments, similar to Maricopa and Coconino Counties (in the latter case, driven by surgical/medical instruments).

Figure 4-4: Commodity Group Distribution of In-State Freight Generated in Arizona, by County



Source: CPCS analysis of Transearch data (2013)

Figure 4-5: Commodity Group Distribution of Out-of-State Freight Generated in Arizona, by County

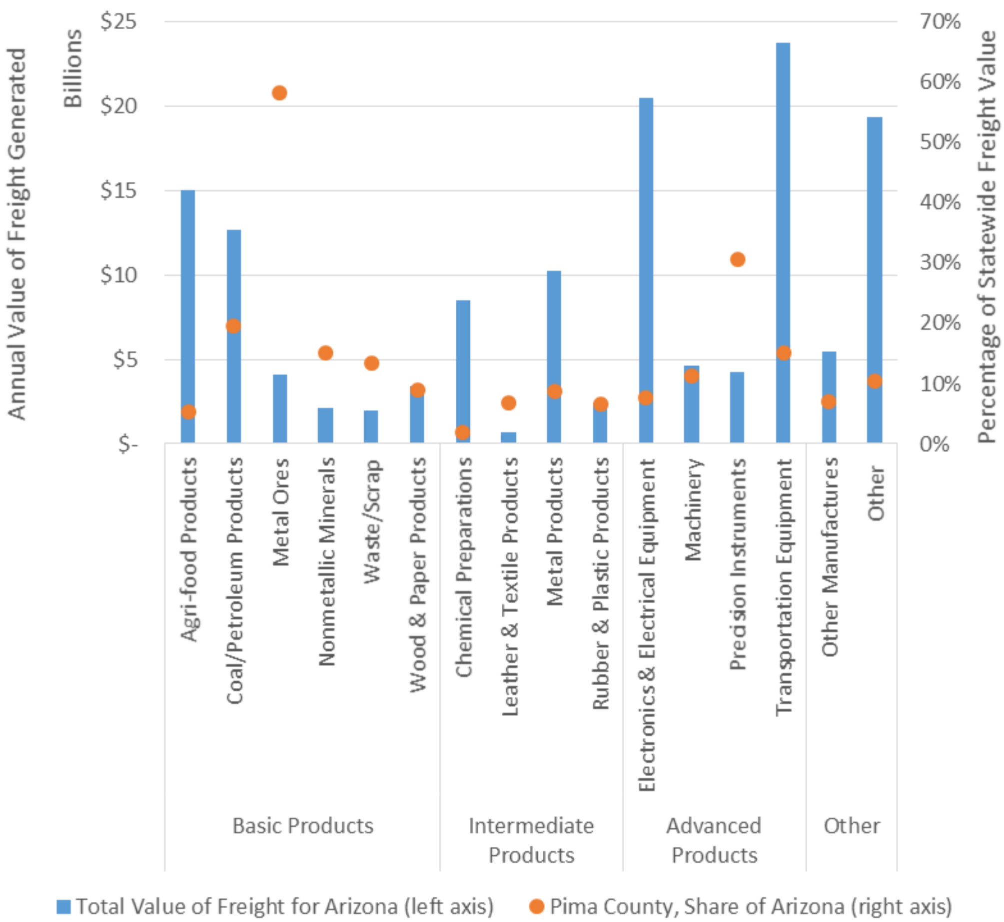


Source: CPCS analysis of Transearch data (2013)

Figure 4-6 shows total freight generation for Arizona by commodity (on the left axis), as well as Pima County's share on the right axis. Notably, Pima County generates a large percentage (58%) of Arizona's Metal Ores. It also produces 31% of Precision Instruments and more than 10% of Coal/Petroleum Products, Transportation Equipment, Nonmetallic Minerals, Waste/Scrap, and Machinery.

Pima County's share of Arizona freight generation is lowest for Chemical Preparations (2%) and Agri-food Products (5%).

Figure 4-6: Annual Freight Generated by Commodity, Arizona Total and Pima County Share



Source: CPCS analysis of Transearch data (2013)

Figure 4-7 further breaks down the top Arizona counties, by ranking, for freight generation in each commodity group. Maricopa County is the top generator for most commodity groups. Pima County generally ranks among the top two or three counties for most commodity groups. The exceptions are Leather and Textile Products (a very low-value commodity in Arizona), as well as Agri-food Products and Chemical Preparations.

This parallels the findings of the previous table that Agri-food Products and Chemical Preparations are underrepresented in Pima County compared with other counties in Arizona. In the case of agri-food, Pinal County's livestock industry, Yuma County's fresh vegetables, and Santa Cruz County's malt liquors and oils/fats put those counties over Pima. In the case of Chemical Preparations, Pinal and Santa Cruz Counties both generate industrial chemicals, while Cochise County produces fertilizers.

Figure 4-7: Top Arizona Counties by Freight Generation, by Commodity Group

	Commodity Category	1	2	3	4	5
Basic Products	Agri-food Products	Maricopa	Yuma	Pinal	Santa Cruz	Pima
	Coal/Petroleum Products	Maricopa	Pima	Coconino	Apache	Mohave
	Metal Ores	Pima	Greenlee	Gila	Pinal	Mohave
	Nonmetallic Minerals	Maricopa	Pima	Pinal	Yavapai	Mohave
	Waste/Scrap	Maricopa	Pima	Pinal	Yavapai	Yuma
	Wood & Paper Products	Maricopa	Pima	Navajo	Mohave	Coconino
Intermed. Products	Chemical Preparations	Maricopa	Santa Cruz	Pinal	Cochise	Pima
	Leather & Textile Products	Maricopa	Yuma	Santa Cruz	Pima	Mohave
	Metal Products	Maricopa	Gila	Pima	Santa Cruz	Pinal
	Rubber & Plastic Products	Maricopa	Pima	Mohave	Yavapai	Santa Cruz
Advanced Products	Electronics & Electrical Equipment	Maricopa	Pima	Santa Cruz	Yavapai	Yuma
	Machinery	Maricopa	Pima	Santa Cruz	Yuma	Cochise
	Precision Instruments	Maricopa	Pima	Coconino	Santa Cruz	Mohave
	Transportation Equipment	Maricopa	Santa Cruz	Pima	Yavapai	Mohave
Other	Other Manufactures	Maricopa	Pima	Yavapai	Santa Cruz	Yuma
	Other	Maricopa	Pima	Coconino	Yuma	Pinal

Source: CPCS analysis of Transearch data (2013)

4.2 National Comparisons of Tucson Metropolitan Area

The study team performed a benchmarking analysis to investigate how the Tucson metropolitan statistical area (MSA) compares to similar-sized metropolitan areas nationally. This exercise consisted of two parts: first, Tucson was compared with other metropolitan areas on the basis of employment in freight-related industries; second, it was compared on the basis of the value of freight generated.

For the comparison, the 30 U.S. metropolitan areas with populations most similar to Tucson were identified (15 larger, 15 smaller). The selected cities are shown in Figure 4-8 along with their 2015 population, per the U.S. Census Bureau.[8]

Excluded were metropolitan areas that are a secondary part of a larger combined statistical area (specifically those that comprise less than 50% of their CSA by population, such as Bridgeport, CT, Worcester, MA, and Oxnard, CA, which are part of the New York, Boston, and Los Angeles CSAs, respectively).

Figure 4-8: National Comparator Metropolitan Areas

Metro	Population (mil.), 2016	Metro	Population (mil.), 2016
Nashville, TN	1.87	Honolulu, HI	0.99
Norfolk, VA	1.73	Tulsa, OK	0.99
Milwaukee, WI	1.57	Fresno, CA	0.98
Jacksonville, FL	1.48	Omaha, NE	0.92
Oklahoma City, OK	1.37	Albuquerque, NM	0.91
Memphis, TN	1.34	Greenville, SC	0.88
Raleigh, NC	1.30	Bakersfield, CA	0.88
Louisville, KY	1.28	Albany, NY	0.88
Richmond, VA	1.28	Knoxville, TN	0.87
New Orleans, LA	1.27	McAllen, TX	0.85
Hartford, CT	1.21	El Paso, TX	0.84
Birmingham, AL	1.15	Baton Rouge, LA	0.84
Buffalo, NY	1.13	Columbia, SC	0.82
Rochester, NY	1.08	Dayton, OH	0.80
Grand Rapids, MI	1.05	North Port, FL	0.79
Tucson, AZ	1.02		

Source: U.S. Census Bureau

[8] U.S. Census Bureau, "Population and Housing Unit Estimates Datasets," 2016. Accessed March 2017.

4.2.1 Comparison of Freight-Related Employment

The comparator cities were evaluated on the basis of employment in freight-related industries. The advantage of evaluating employment is that reliable and consistent employment data are available for all metropolitan areas through the County Business Patterns (CBP) database, compiled by the U.S. Census Bureau.[9] The most recent data available from this resource are for 2014. The Tucson MSA is defined as Pima County.

CBP data are extracted from the Business Register, which consists of data from a variety of government sources, including the Economic Censuses, Annual Survey of Manufactures, and Bureau of Labor Statistics records, among other sources. Establishments are coded by the North American Industry Classification System (NAICS), which includes nearly 1,200 industries. Notably, the series does not cover self-employed individuals, employees of private households, railroad employees, agricultural production employees, and most government employees. The dataset does distinguish the locations of multiple establishments for multi-unit companies.[10]

The study team grouped 3-digit NAICS codes into broad economic sectors, according to Figure 4-9.

Figure 4-9: Composition of Economic Sectors

Sector	NAICS Composition	Relation to Freight
Construction & Raw Materials	111–238	Freight-Related
Manufacturing	311–339	Freight-Related
Transportation & Wholesale Trade	411–425; 481–493 excluding 485 and 487	Freight-Related
Retail Trade & Food Service	441–454; 721–722	Retail-Related
Non-Retail Service	485; 487; 562–814 excluding 721 and 722	Non-Freight Related
Office & Professional	511–561	Non-Freight Related

Source: CPCS

The Construction and Raw Materials, Manufacturing, and Transportation and Wholesale Trade sectors are classified as freight-related, as these sectors by nature involve the extraction, production, or transportation of goods. Retail Trade and Food Service is listed separately, as this sector inherently involves some goods movement (i.e. local deliveries), although of a much smaller magnitude than the three sectors classified as freight-related. Non-Retail Service and Office and Professional are classified as non-freight related. While these sectors do generate some freight traffic (e.g., shredding services, mail and parcel deliveries, deliveries to hospitals, etc.), it is not a core part of their business.

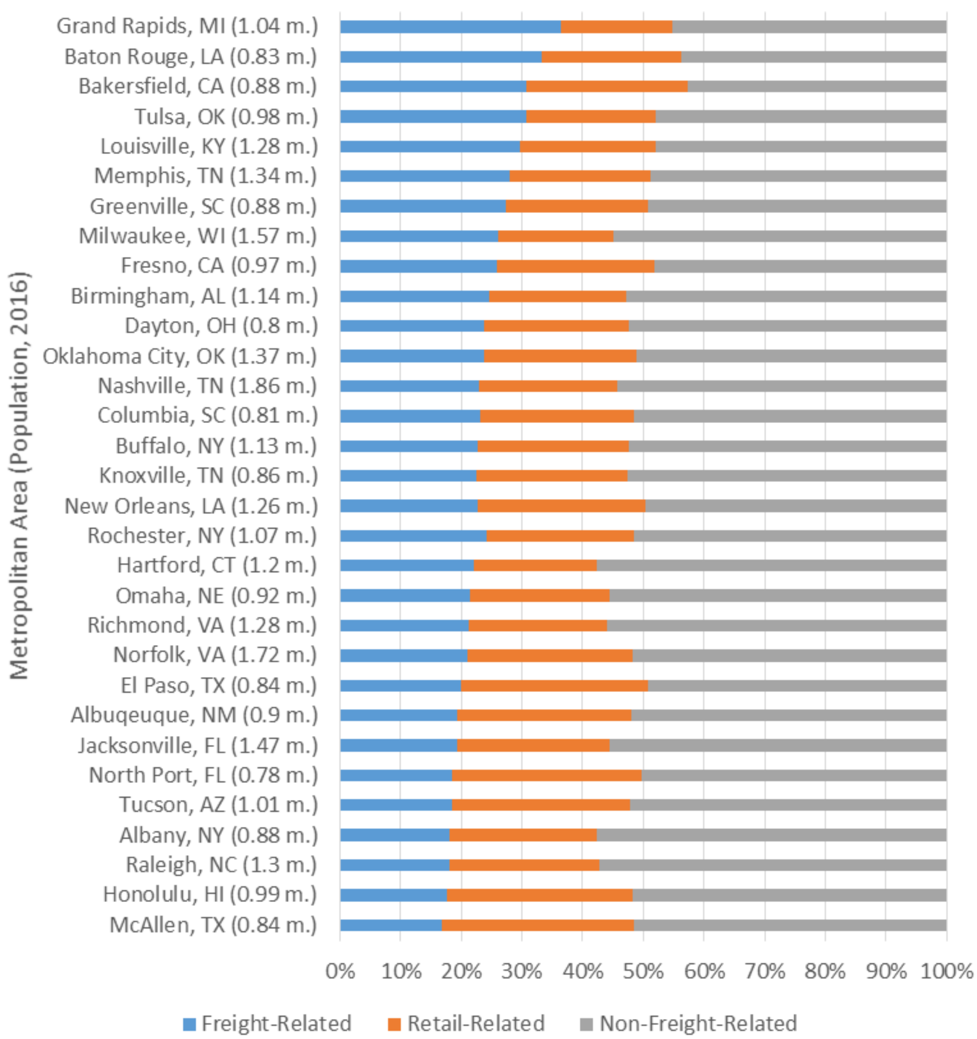
[9] U.S. Census Bureau, "County Business Patterns Datasets,"2014. Accessed March 2017.
[10] U.S. Census Bureau, "CBP Methodology," Updated October 2016. Accessed March 2017.

Employment

Figure 4-10 shows the breakdown of employment by metropolitan area among the comparator cities, ordered by population. Among the comparator cities, the largest share of freight-related employment is in Grand Rapids (36%), followed by Baton Rouge (33%) and Bakersfield (31%).

At 18%, Tucson ranks among the metropolitan areas with the lowest share of freight-related employment, ahead of only Albany (18%), Raleigh (18%), Honolulu (17%), and McAllen (17%).

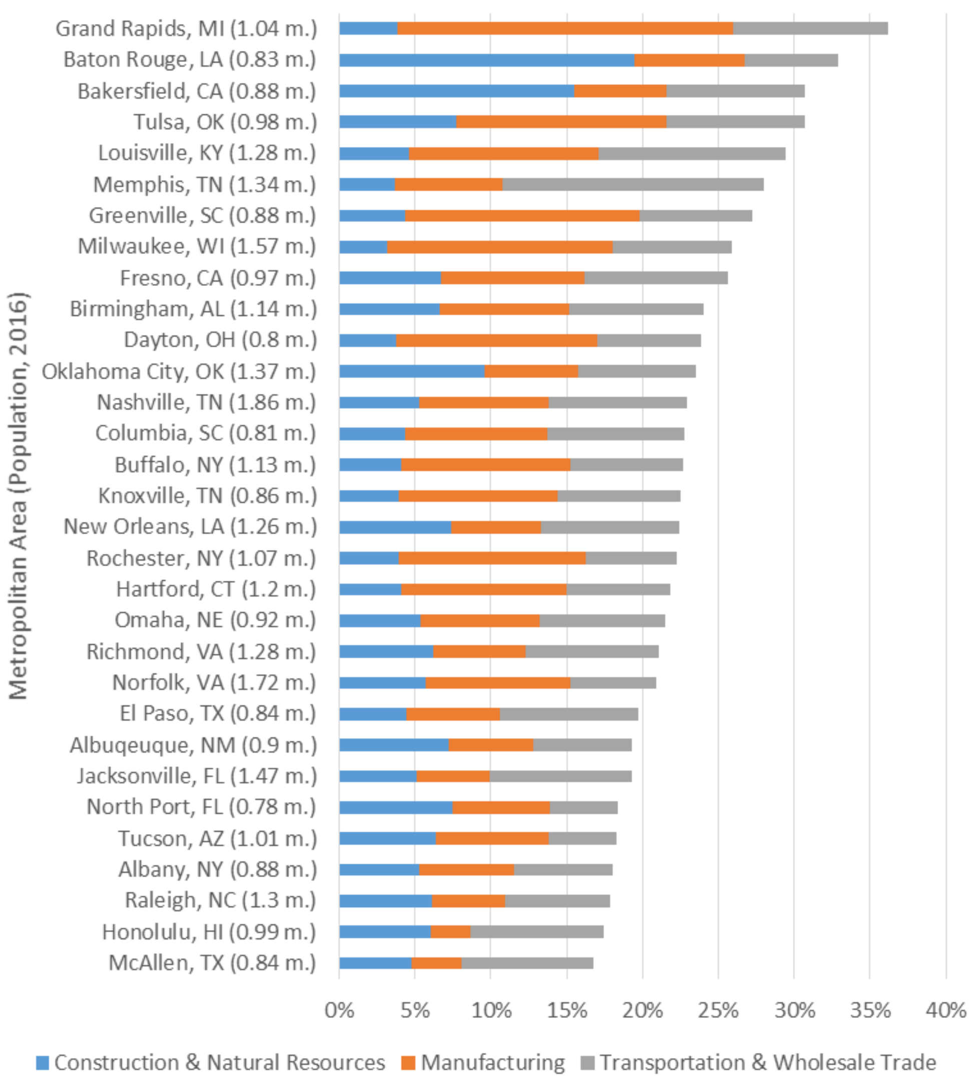
Figure 4-10: Employment by Sector Distribution Among Comparator Cities



Source: CPCS analysis of County Business Patterns data (2014)

Figure 4-11 shows the breakdown of freight-related employment, among Construction and Raw Materials, Manufacturing, and Transportation and Wholesale Trade.

Figure 4-11: Employment by Freight-Related Sector, among Comparator Cities



Source: CPCS analysis of County Business Patterns data (2014)

As supported by Figure 4-12, Tucson ranks in the top ten with regard to Construction and Raw Materials jobs. It ranks 17th out of 31 in Manufacturing-sector jobs, outperforming the average in computer and electrical equipment/electronic products, as well as beverage manufacturing (and presumably Transportation Equipment, although this data is suppressed).[11] Among manufacturing industries, Tucson is most underrepresented in food products, machinery, plastics and rubber, and fabricated metal products.

Tucson ranks 31st out of 31 in Transportation and Wholesale Trade employment. Notably, Tucson has well under the average in durable and non-durable wholesale trade jobs, as well as truck transportation jobs. Businesses in this sector generally benefit from a central location nationally; the top metropolitan areas by employment are Memphis, Louisville, and Salt Lake City, while the bottom metropolitan areas are Tucson, North Port, and Virginia Beach.

Tucson also ranks fifth in Retail and Food Service jobs, driven by well above-average employment in accommodation and food services and drinking places. It also ranks third in Non-Retail Service jobs, driven largely by healthcare, and 22nd in Office jobs. It is noted that Tucson's and Arizona's high proportion of retirees compared with the national average drives up demand for health services, which explains the high percentage of non-retail service jobs.

Figure 4-12: Tucson Freight-Related Employment, as Percentage of Jobs, versus Comparator Cities

	Constr. & Raw Mat'l	Mfg	Transp & Whls Trade	Retail	Non-Ret Service	Office
Tucson, AZ	6%	7%	4%	29%	37%	15%
Average, 31 Cities	6%	9%	8%	25%	34%	17%
Tucson Rank	10	17	31	5	3	22

Source: CPCS analysis of County Business Patterns data (2014)

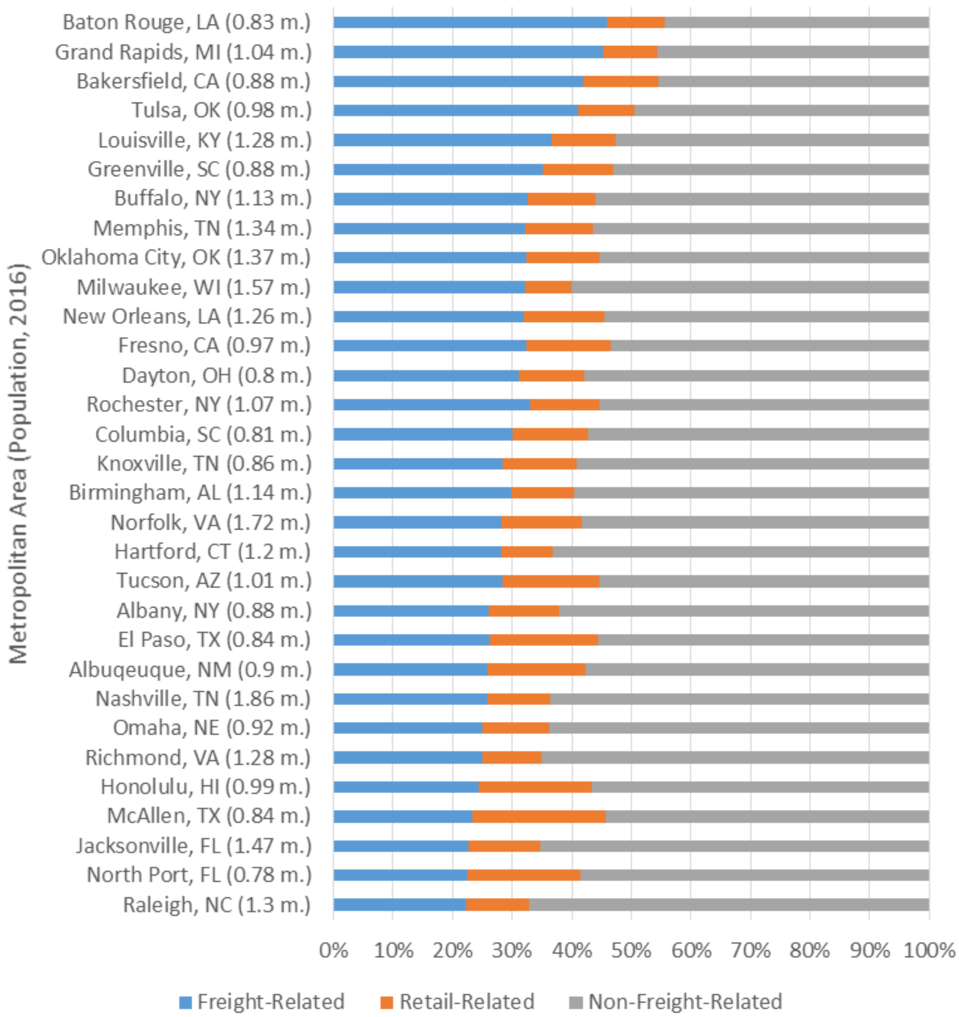
Payroll

Total annual payroll is also provided in the CBP dataset and represents an alternative to employment for cross-metro comparisons. Payroll may also be a rough proxy for the value of goods or services produced (although not a perfect one, because of different levels of capital productivity between industries).

[11] Data are suppressed in cases where publication would enable inferences about data for specific companies. It should be noted that withheld data are included in higher level totals. For example, for Tucson, employment in NAICS 336 (Transportation Equipment Manufacturing) is withheld, but this does not impact the total for NAICS 31-33 Manufacturing. This study uses two-digit NAICS codes (subtracting individual three-digit codes where industries are split into multiple sectors). Thus, Transportation Equipment manufacturing employment is included in the total for manufacturing, even though it is not possible to isolate this industry individually.

As shown in Figure 4-11, Tucson ranks 20th among the 31 comparator cities on the basis of total payroll for freight-related sectors. This is below average but higher than the employment rank, suggesting an above-average payroll-to-employee ratio in the Tucson MSA.

Figure 4-13: Total Payroll Distribution by Sector among Comparator Cities



Source: CPCS analysis of County Business Patterns data (2014)

Overall, Tucson's payroll per employee is $38,734, which ranks 27th among the comparator cities. However, a big exception to this is the manufacturing sector, where Tucson ranks 4th at $74,133 per employee (Figure 4-14).

Figure 4-14: Payroll Divided by Employment, by Sector, for Tucson Metropolitan Area

	Constr. & Raw Mat'l	Mfg	Transp & Whls Trade	Retail	Non-Ret Service	Office
Tucson, AZ	$45,539	$75,133	$53,234	$21,277	$34,990	$55,478
Tucson Rank	27	4	21	15	25	28

Source: CPCS analysis of County Business Patterns data (2014)

Studying the manufacturing sector in a greater depth suggests that the higher wages are largely generated by Transportation Equipment manufacturing, although this cannot be explicitly concluded from the data. Figure 4-15 shows a comparison of Tucson to comparator cities for selected manufacturing industries (those with the highest employment across cities).

In general, Tucson has lower payroll per employee for most industries within the sector. However, the residual manufacturing category for Tucson has a very high employment and payroll per employment. The residual category includes three-digit NAICS codes that are suppressed at the 3-digit level but included in higher order (two-digit) subtotals. Judging by Transearch data on shipments by commodity, as well as publically available employment data for the city, this residual category appears to consist largely of Transportation Equipment manufacturing, notably Raytheon. The high payroll per employee in this residual category is what explains Tucson's high ranking in manufacturing payroll per employee.

Figure 4-15: Employment and Payroll for Selected Manufacturing Industries

Industry	Tucson Pct. of Employment	Comparators Pct. of Employment	Tucson Payroll per Employee	Comparators Payroll per Employee
Chemical manufacturing	*	0.5%	*	$ 77,768
Computer and electronic product manufacturing	0.6%	0.4%	$ 60,098	$ 72,802
Electrical equipment, appliance, and component manufacturing	0.1%	0.3%	$ 54,770	$ 57,577
Fabricated metal product manufacturing	0.9%	1.2%	$ 47,699	$ 52,813
Food manufacturing	0.2%	1.0%	$ 27,880	$ 43,641
Machinery manufacturing	0.4%	1.0%	$ 52,689	$ 59,633
Miscellaneous manufacturing	0.4%	0.4%	$ 37,853	$ 55,577
Non-metallic mineral product manufacturing	0.3%	0.3%	$ 48,806	$ 49,639
Plastics and rubber products manufacturing	0.1%	0.6%	$ 40,748	$ 47,287
Printing and related support activities	0.2%	0.4%	$ 36,027	$ 43,072
Transportation Equipment manufacturing	*	0.7%	*	$ 59,009
Residual manufacturing	3.6%		$ 105,555	

Source: CPCS analysis of County Business Patterns data (2014). *withheld at the three-digit NAICS level.

4.2.2 Comparison of Freight Generation (with FAF)

While employment is part of the story, another part is freight generation. Since productivity varies by industry, freight generation is a better indicator than employment of the importance of freight to a regional economy. Freight generation data are available from the FAF. The FAF zone for Tucson consists of Pima County.

FAF is a publically available dataset developed by the Federal Highway Administration. The latest version (FAF4), made available as of 2015 with ongoing supplements released since, is based on the 2012 Commodity Flow Survey (part of the Economic Census), supplemented by other sources.[12]

The major downside of this source is that FAF zones are not defined separately for all metropolitan areas. Of the 30 comparators, the following metropolitan areas were removed due to lack of data: Albuquerque, Bakersfield, McAllen, Columbia, Honolulu, and North Port. In addition, Raleigh was removed because the FAF zone for this city is significantly larger than the MSA alone (combined with Durham). The remaining metropolitan areas among the comparator group do have FAF zones, although the geographic definitions do not always align (for example, Louisville's FAF zone only includes the Kentucky portion). Thus, while FAF presents an alternative and complementary picture of freight activity compared with CBP, the two datasets should not be directly compared.

[12] Freight Analysis Framework Version 4 (FAF4), Updated March 2017. Accessed February 2017.

Results

Figure 4-16 shows the annual value, in millions of dollars, of freight originating in each FAF zone, segmented as domestic, export, and import (in the latter case the city listed is the domestic origin of an imported shipment). The FAF data support the employment-based findings that Tucson generates a relatively small amount of freight relative to its size. (Although Tucson appears to rank last among comparators, as noted, some of the cities with missing FAF zones—such as McAllen and North Port—likely have similarly low levels of freight generation, though this is not identifiable from the data).

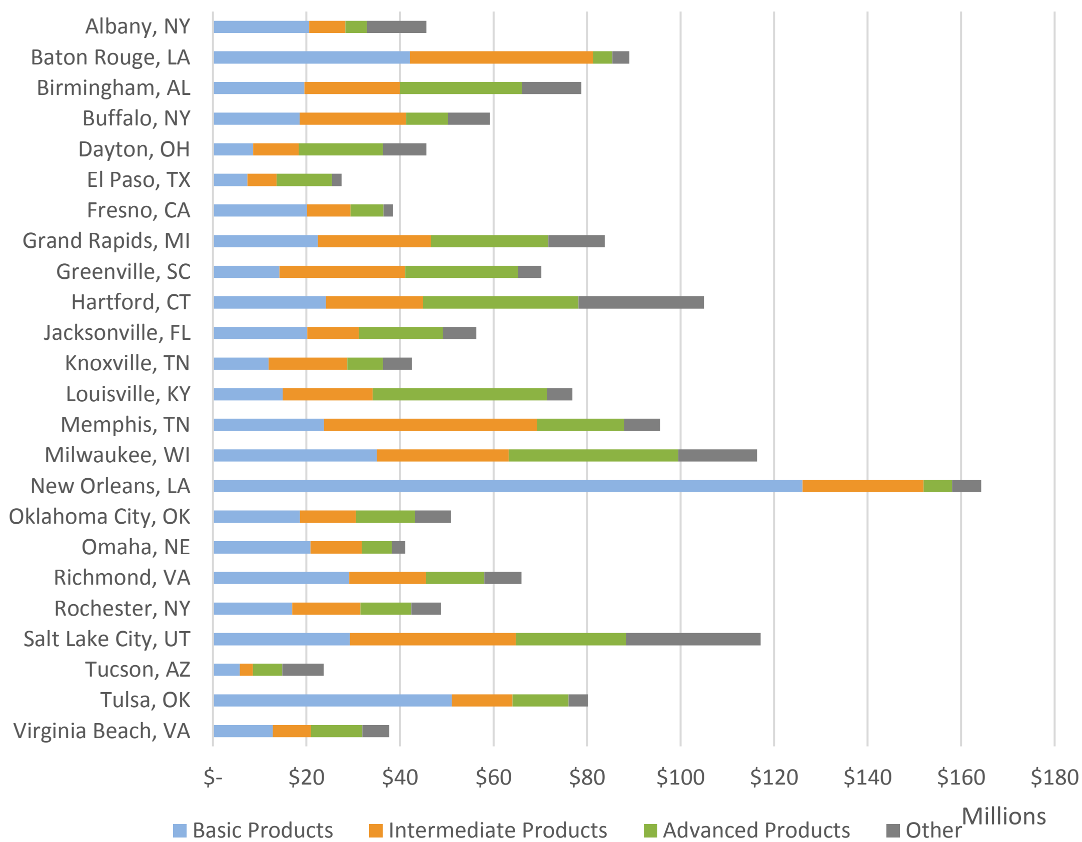
Figure 4-16: Value of Freight Originating in Each FAF Zone

Source: CPCS analysis of FAF data (2012)

The "other" category includes miscellaneous manufactured products, mixed freight, Waste/Scrap, and unknown.

Figure 4-17 breaks down domestic and export flows (imports not included) originating in each zone, by commodity category. Although Tucson is underrepresented in all categories relative to comparator cities, it is particularly underrepresented for Intermediate Products, which includes Metal Products, chemicals, and plastic/rubber products.

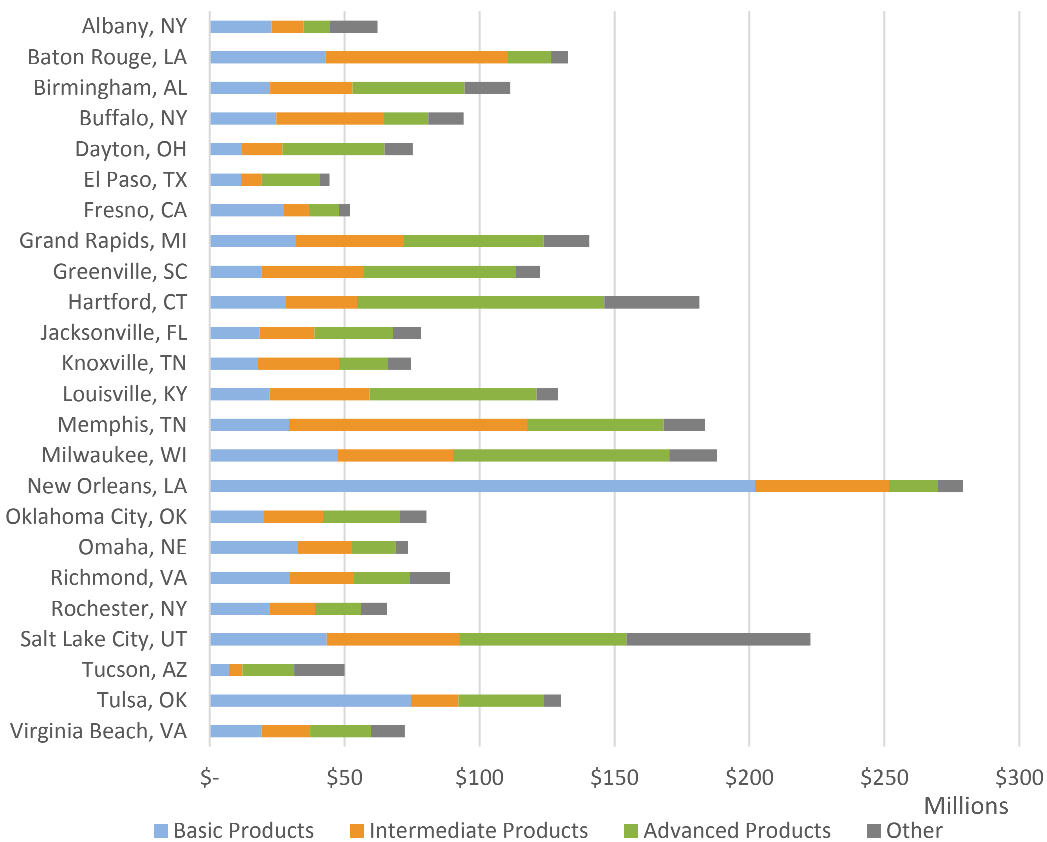
Figure 4-17: Value of Domestic and Export Freight Originating in Each FAF Zone



Source: CPCS analysis of FAF data (2012)

FAF also includes projections of future freight flows. Figure 4-18 shows projected freight generation in the year 2040. Domestic and export freight generation in the Tucson area (i.e. the FAF area) is projected to grow from $24 b. in 2012 to $50 b. in 2040, although its relative position compared with comparator cities is not expected to change significantly.

Figure 4-18: Projected 2040 Value of Domestic and Export Freight Originating in Each FAF Zone



Source: CPCS analysis of FAF data (2012)

4.3 Benchmarking with MAP Dashboard Cities

Another basis of comparison is with the MAP Dashboard cities. The MAP Dashboard[13] is a data-driven online resource developed through a partnership involving the Community Foundation for Southern Arizona, Pima Association of Governments, the Southern Arizona Leadership Council, and the University of Arizona. It tracks southern Arizona's (i.e., the Tucson MSA's) performance across a diverse set of 36 indicators across six dimensions: economy, education, health and social wellbeing, infrastructure, quality of place, and workforce and demographics.

A key part of the MAP Dashboard is a comparison between regions. Of particular note is the identification of 11 cities in the western United States selected by stakeholders as appropriate comparators for the Tucson MSA. These cities (MSAs) are listed in Figure 4-19:

Figure 4-19: MAP Dashboard Cities

Metropolitan Statistical Area	Population, 2016 (m.)
Albuquerque, NM	0.91
Austin, TX	2.06
Colorado Springs, CO	0.71
Denver, CO	2.85
El Paso, TX	0.84
Las Vegas, NV	2.16
Phoenix, AZ	4.66
Portland, OR	2.42
Salt Lake City, UT	1.19
San Antonio, TX	2.43
San Diego, CA	3.32
Tucson, AZ	**1.02**

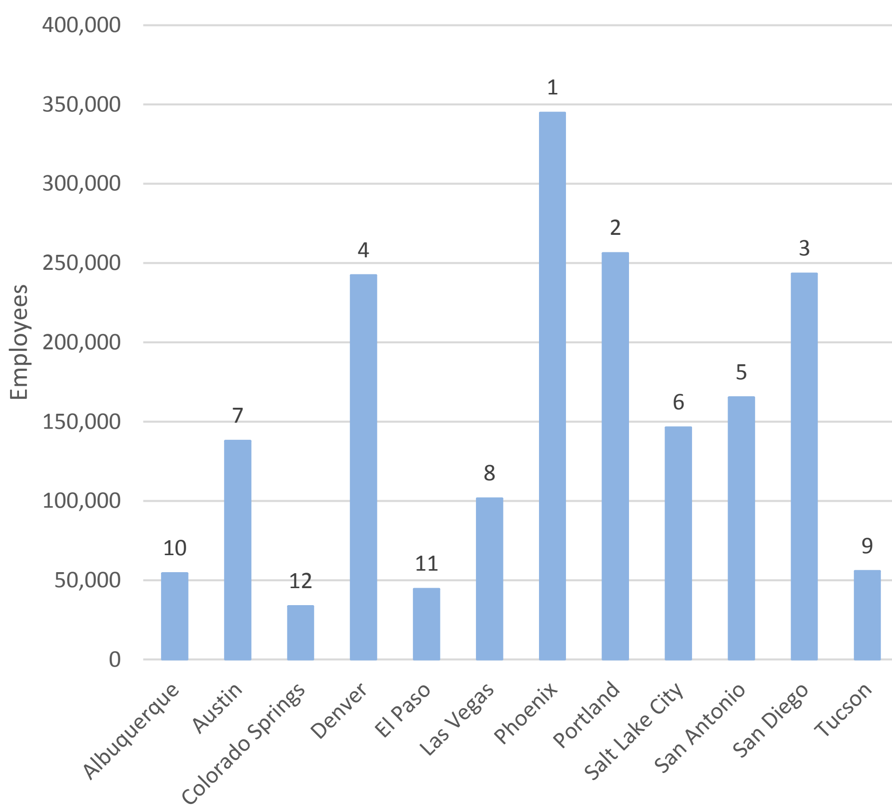
Source: Population from U.S. Census Bureau

[13] MAP Dashboard website, accessed May 2017

4.3.1 Comparison of Freight-Related Employment

Figure 4-20 shows the absolute number of employees in freight-related fields (previously defined as construction and natural resources, manufacturing, and transportation/wholesale trade). The number above each column represents the rank of each city.

Figure 4-20: Freight-Related Employment, MAP Dashboard MSAs

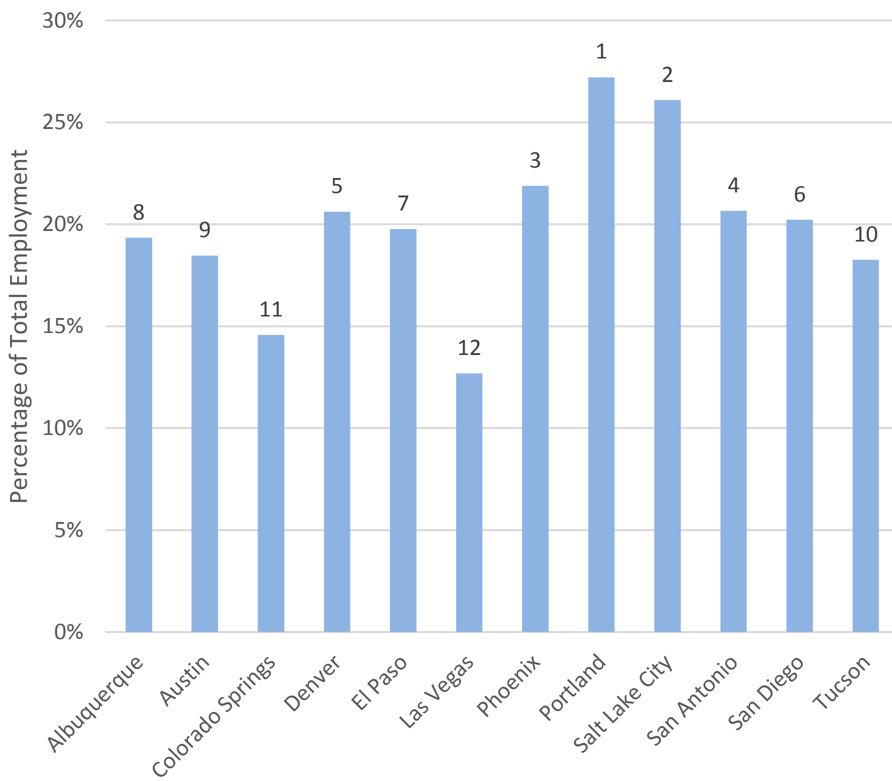


Source: CPCS analysis of County Business Patterns data (2014)

Expectedly, the cities with the most freight-related employment are also those with the largest populations, notably Phoenix, Portland, San Diego, and Denver. Tucson ranks ninth, ahead of Albuquerque, El Paso, and Colorado Springs (which all have a lower metropolitan population).

Figure 4-21 shows freight-related employment as a percentage of total employment, by MSA. The cities with the highest share of freight-related employment are Portland, Salt Lake City, and Phoenix. Tucson ranks 10th, ahead of Colorado Springs and Las Vegas.

Figure 4-21: Freight-Related Employment as Percentage of Total Employment, MAP Dashboard MSAs



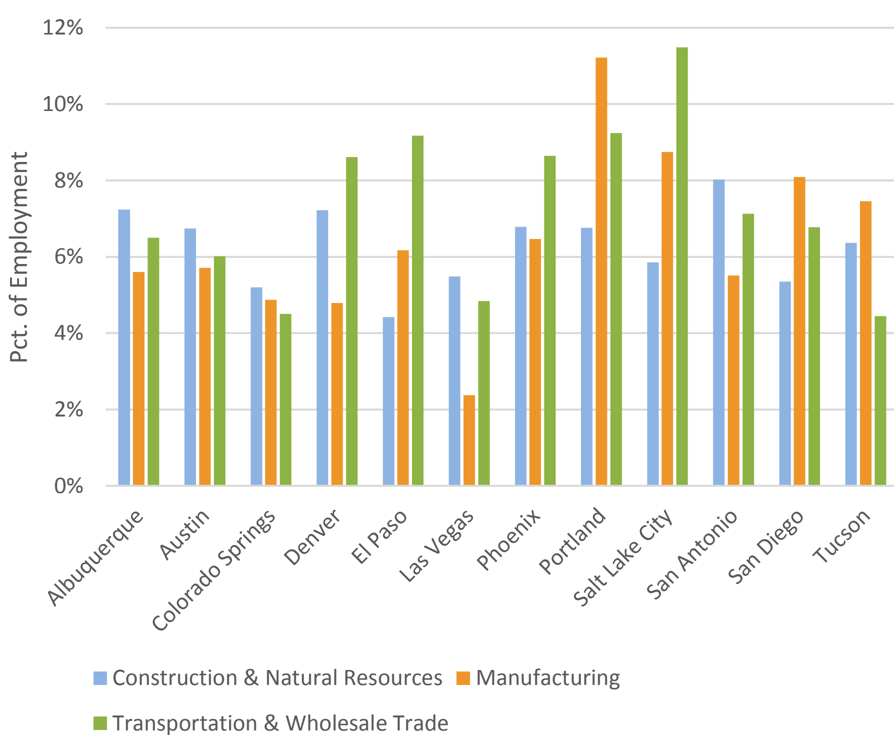
Source: CPCS analysis of County Business Patterns data (2014)

Figure 4-22 displays a breakdown of freight-related employment by sector for each of the MAP Dashboard cities. Among top-ranked cities:

- Portland's freight-related employment is driven mostly by manufacturing (especially computer and electronics, and Metal Products), as well as transportation (including the port and related logistics/distribution functions.
- For Salt Lake City, the transportation sector stands out, including trucking and wholesale trade. Manufacturing employment is also relatively high.
- Phoenix's freight-related employment is relatively balanced, with significant employment in wholesale trade, construction, and manufacturing (including computer and electronic products, Metal Products, and Transportation Equipment).

Of note, Tucson ranks 7th among comparator cities in construction and natural resources, 4th in manufacturing, and 12th in transportation and wholesale trade, generally mirroring the same patterns seen in the comparisons among 30 national cities in the previous section. Tucson's performance in manufacturing stands out positively compared with other MAP Dashboard cities. On the other hand, transportation and wholesale trade employment stands out as negative.

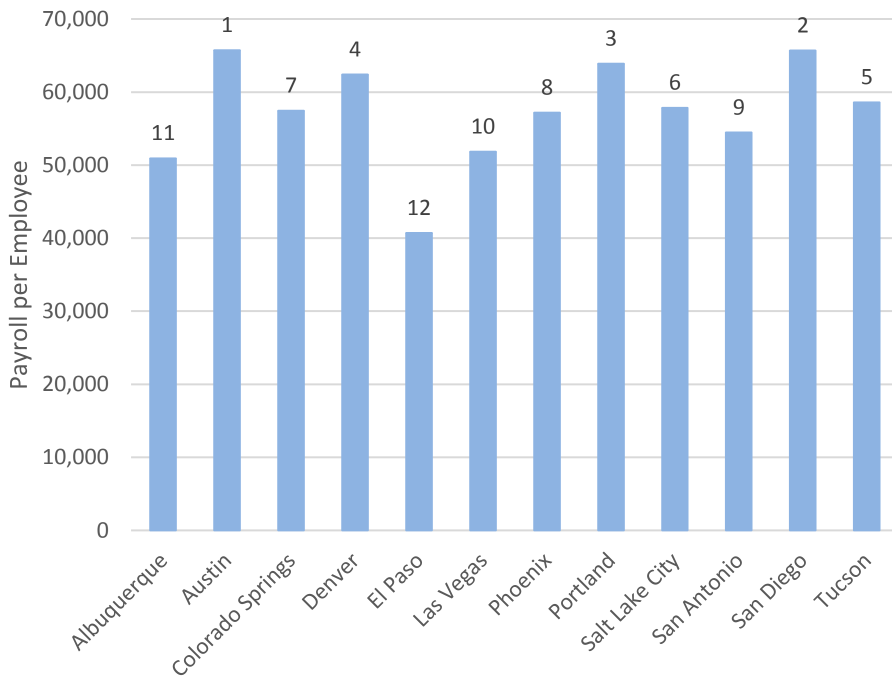
Figure 4-22: Breakdown of Freight-Related Employment by Sector, MAP Dashboard MSAs



Source: CPCS analysis of County Business Patterns data (2014)

Figure 4-23 shows payroll per employee, which is a proxy for wages as well as, to some extent, value added. On this score, Tucson performs relatively well compared with other MAP Dashboard cities, ranking 5th out of 12. The top ranking cities are Austin, San Diego, and Portland, while the lowest are Las Vegas, Albuquerque, and El Paso.

Figure 4-23: Payroll per Employee for Freight-Related Employment, MAP Dashboard MSAs



Source: CPCS analysis of County Business Patterns data (2014)

Figure 4-24 illuminates some of the factors explaining the relatively high payroll per employee for Tucson's freight economy, compared with other MAP Dashboard cities. First and foremost, Tucson's manufacturing payroll per employee is high, at $75,000, much higher than in other cities, suggesting that Tucson's manufacturing activity is higher value and more advanced than that in other cities.

Tucson's payroll per employee is below average for most other sectors, and in many cases well below average. It ranks 11th in other freight-related sectors (aside from manufacturing) and 10th or 11th in other sectors. Economy-wide, Tucson ranks ahead of Albuquerque and El Paso in payroll per employee, but behind other MAP Dashboard cities. The top metropolitan areas (MSAs) economy-wide are Denver, Austin, and Portland.

Figure 4-24: Payroll per Employee by Sector, MAP Dashboard MSAs

	Constr. & Raw Mat'l	Mfg	Transp & Whls Trade	Retail	Non-Ret Service	Office	All Sectors
Albuquerque	$49,825	$52,562	$50,613	$22,087	$37,277	$52,851	$38,285
Austin	$57,543	$66,307	$74,161	$23,056	$39,229	$87,853	$51,744
Colorado Springs	$48,807	$57,479	$67,225	$22,742	$40,746	$63,189	$43,139
Denver	$66,573	$55,796	$62,463	$23,765	$41,602	$92,408	$55,128
El Paso	$36,780	$39,121	$43,566	$18,370	$31,629	$43,411	$31,170
Las Vegas	$51,329	$45,449	$55,426	$29,558	$37,128	$59,159	$38,977
Phoenix	$52,213	$63,522	$56,194	$23,385	$40,869	$68,873	$45,952
Portland	$61,006	$64,842	$64,743	$23,490	$40,447	$81,786	$51,527
Salt Lake City	$55,028	$59,317	$58,080	$24,062	$38,316	$62,599	$46,890
San Antonio	$57,340	$49,423	$55,004	$21,548	$35,832	$69,460	$42,566
San Diego	$55,107	$68,487	$70,579	$24,416	$42,801	$80,133	$51,349
Tucson	$45,539	$75,133	$49,348	$21,277	$34,990	$54,918	$38,734
Average, 12 Cities	$53,091	$58,120	$58,950	$23,146	$38,406	$68,053	$44,622
Tucson Rank	11	1	11	11	11	10	10

Source: CPCS analysis of County Business Patterns data (2014)

Conclusions

Comparison of the MAP Dashboard cities reveals patterns that are broadly similar to the comparisons among 30 cities nationwide:

- Tucson's freight-related employment is driven by manufacturing, which is higher value than manufacturing in many other cities.
- Tucson's employment in transportation and wholesale trade is very low in comparison with other cities.
- Manufacturing is a key driver of Tucson's regional economy, though it is important to contemplate the risk of reliance on one sector and one or a few key employers.

5 Focus on Outflows and Through-Flows

Key Chapter Takeaway

- The literature on regional economic goals as related to commodity flows reveals two notable themes: increasing exports/outflows of high-tech Advanced Products, and taking advantage of Tucson's through-flows to develop logistics hubs/clusters.
- This chapter explores these two themes, in describing the present-day situation with regard to existing commodity flows, to lay the foundation for potential future studies to further investigate these themes.
- Pima County has $2.7 b. in outbound out-of-state Advanced Products flows, which increases to $9.4 b. if all missile flows are assumed to be out-of-state. Thus, missiles are 71% of out-of-state Advanced Products flows, which is an indicator of their importance to the regional economy but also an argument for continuing to develop other high-tech export industries.
- Pass-through truck flows through Pima County are approximately $151 b. annually, or about 77% of all truck flows (including inbound, outbound and internal). Much of this consists of flows from Los Angeles to the Southwest and beyond.
- This study illuminates some of the pass-through commodities with the greatest geographical balance in terms of origins and destinations, which could be candidates for follow-up study.

5.1 Regional Economic Goals

Several regional policy documents are noteworthy for their attention to freight-related economic activity and goals.

5.1.1 Key Regional Economic Policy Documents

Transportation and Trade Corridor Alliance Roadmap

The Transportation and Trade Corridor Alliance (TTCA) Roadmap[14] was completed in 2014, a product of a partnership between the Arizona Commerce Authority, ADOT, and the Arizona-Mexico Commission. The stated focus of the Roadmap is:

> *"Creating better jobs and higher household incomes by growing value-added industries that bring new money to Arizona [… through] modern and efficient infrastructure to ensure effective connectivity to both domestic and global markets."*

Key aspects of the Roadmap include:

- Growing tradable goods and services "exported" from the local economy to outside markets.
- Taking advantage of Arizona's geographic location between Southern California, central Texas, and northern Mexico to improve connectivity to markets.

Under the action plan for expanding global commerce, several items specifically relate to goods movement:

- (Point 1) Use a supply chain strategy to further develop the tradable goods sector.
- (Point 2) Strengthen relationships and business linkages with Arizona's key trade partners: Mexico, California and Texas are highlighted, as well as international partners such as Canada and the UK
- (Point 4) Develop multidirectional and multimodal logistics hubs.
- (Point 6) Double Arizona's exports to Mexico by 2020.

Sun Corridor 2014 Economic Blueprint Update

Another regional policy document of importance is the 2014 Economic Blueprint Update[15] prepared by Sun Corridor Inc. (at the time, Tucson Regional Economic Opportunities – TREO). This report was an update to the original 2007 Economic Blueprint designed to guide the region's economic development efforts to support its future competitiveness.

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[14] Transportation and Trade Corridor Alliance, "The Roadmap: Arizona's Path to Global Market Expansion." (2014)

[15] Tucson Regional Economic Opportunities, "We Win as One: 2014 Economic Blueprint Update: Setting Priorities to Advance Prosperity in Southern Arizona." (2014)

The key recommendations of the report are: growing a talented workforce, ensuring the right transportation infrastructure, supporting a business-friendly environment, and making Tucson a healthy region in which to live and work. Under infrastructure, the first item is: "Achieve seamless connectivity to Mexico and other Southwestern business markets."

Other items listed under the "Infrastructure point" involve supporting air and rail infrastructure (including for intermodal transportation) and developing new and creative funding mechanisms for transportation infrastructure.

5.1.2 Key Areas of Focus for Commodity Flows

Collectively, these policy documents suggest two overarching themes related to commodity flows in Southern Arizona:

- High-value Advanced Products that are shipped to destinations across the U.S. and internationally, are important to the region's economic growth.
- The region's geographic position could be leveraged to capture some of the value of goods moving through the region, such as through value-added distribution activities.

While a full investigation of the region's performance against its policy documents is beyond the scope of this study, this report provides some insight into several key variables that relate to these two goals, specifically:

- What are the high-value Advanced Products that the Tucson region (Pima County) ships to domestic and international destinations? How does the Tucson region compare to other similar metropolitan areas?
- What is the nature of through-flows passing through the Tucson region? What are the origins and destinations of these flows, and what commodities are being shipped through the region?

Each of these is explored further in this chapter.

5.2 Focus on: Advanced Product Outflows

For the purpose of this report, Advanced Products were defined in Section 2.1.4. The definition is based on the Transearch STCC codes and is summarized for convenience in **Error! Reference source not found.**Figure 5-1. This section focuses specifically on these Advanced Products.

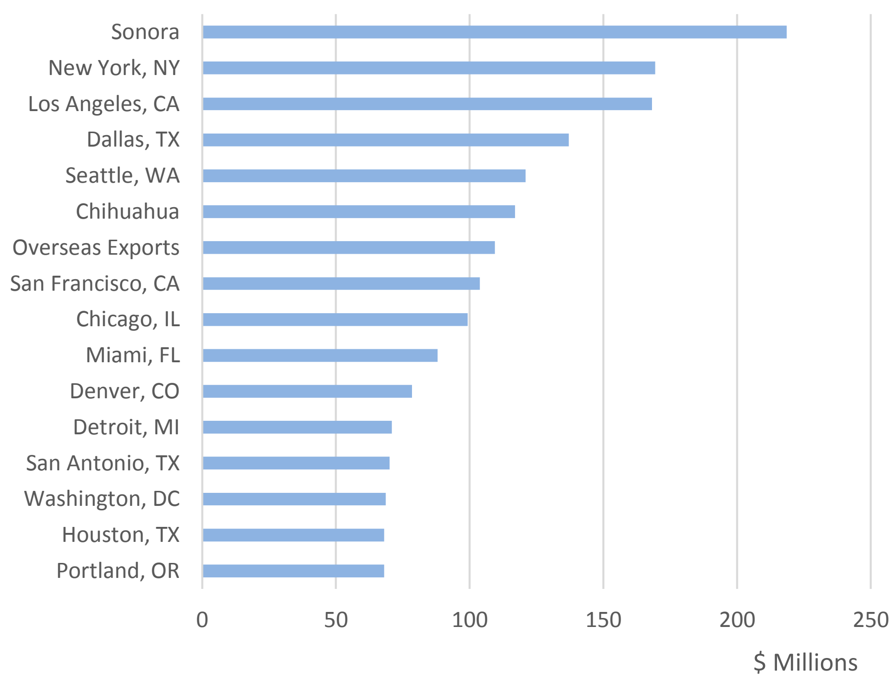
Figure 5-1: Definition of Advanced Products

Advanced Products
Electronics & Electrical Equipment
Machinery
Precision Instruments
Transportation Equipment

5.2.1 Top Destinations for Advanced Products

The top out-of-state destinations for Advanced Products flows from Pima County are shown in Figure 5-2. The top destination is the state of Sonora, with $219 m. of outflows. The next highest destinations are New York, Los Angeles, Dallas, Seattle, and the Mexican state of Chihuahua.

Figure 5-2: Top Out-of-State Destinations for Pima County Outbound Advanced Products

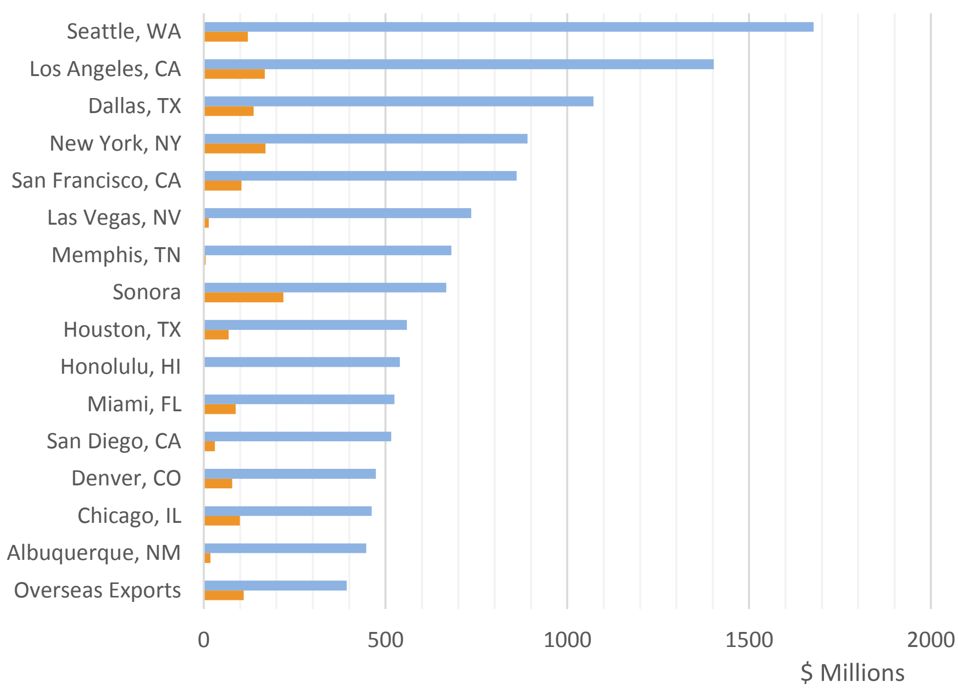


Source: CPCS analysis of Transearch data (2013). Destination listed is the BEA economic region or Mexican state. Note: domestic destination does not include exports routed through the destination.

The graph demonstrates that Advanced Products are shipped from Pima County across the United States as well as abroad, notably to nearby Mexican states. In other words, the supply chain for Advanced Products manufacturers in Pima County is national and global.

One way of benchmarking Pima County's Advanced Products outflows is by comparison to Maricopa County. On this standard, Pima County's Advanced Products outflows are fairly low. Figure 5-3 shows the top out-of-state destinations for Pima versus Maricopa Counties, for Advanced Products. Maricopa ships approximately 14 times the value of Advanced Products to Seattle, and 8 times to Los Angeles, Dallas, and San Francisco compared with Pima County (for reference, Maricopa's population is on the order of 4 times Pima's). Pima County has a ratio better than or proportionate to its population (i.e., below 4) for overseas exports (3.6) and flows to Sonora (3.1).

Figure 5-3: Top Out-of-State Destinations for Outbound Advanced Products: Pima vs. Maricopa Counties



Source: CPCS analysis of Transearch data (2013). Destination listed is the BEA economic region or Mexican state. Note: domestic destination does not include exports routed through the destination.

5.2.2 Top Advanced Product Commodities

Figure 5-4 shows a breakdown of top outbound advanced product commodities. The commodity corresponds to four-digits STCC codes, the most detailed available for Transearch.

Figure 5-4: Top Advanced Product Commodities (Out-of-State Outbound), $M

Detailed Commodity	Category	Maricopa County	Pima County
Electrical Equipment	Electronics & Elec.	$4,427	$471
Misc. Electrical Industrial Equipment	Electronics & Elec.	$1,660	$414
Engineering, Laboratory or Scientific Equipment	Precision Instr.	$12	$389
Instrum. Photo Equipment, Optical Eq.	Precision Instr.	$107	$363
Solid State Semiconductors	Electronics & Elec.	$3,637	$99
Transportation Equipment	Transportation Eq.	$1,453	$89
Orthopedic or Prosthetic Supplies	Precision Instr.	$184	$77
Machinery	Machinery	$1,024	$71
Automatic Temperature Controls	Precision Instr.	$86	$57
Farm Machinery or Equipment	Machinery	$28	$56
Aircraft Propellers or Parts	Transportation Eq.	$129	$48
Constr. Machinery or Equipment	Machinery	$288	$48
Misc. Machinery or Parts	Machinery	$210	$46
Missile or Space Veh. Parts*	Transportation Eq.	$44	$44
Mining Machinery or Parts	Machinery	$15	$43
Refrigeration Machinery	Machinery	$51	$33

Source: CPCS analysis of Transearch data (2013) *Does not include $6.7 m. in missile or space vehicle parts for Pima County

By value, the top commodities from Pima County are electrical equipment, electrical industrial equipment, and engineering/laboratory/scientific equipment. The Transearch data confirm that, compared with Maricopa County, Pima County specializes in optical and scientific equipment, whereas Maricopa County produces more electrical equipment, semiconductors, and Transportation Equipment (such as spacecraft).

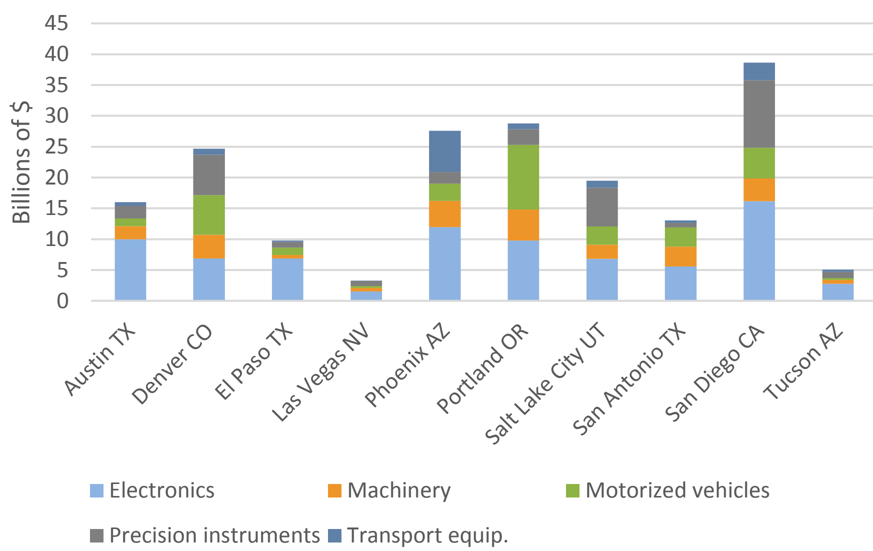
Overall, Maricopa County has out-of-state Advanced Products outflows of $18.3 b. compared with Pima County's $2.7 b., according to the 2013 Transearch data. It should be noted that this does not include the $6.7 b. of missile products for Pima County that is listed as in-state, likely because it is considered terminating at the airport and/or military base (for reference, Maricopa County has $1.0 b. in missile products, including in-state and out-of-state destinations).

5.2.3 Outbound Advanced Products for MAP Dashboard Cities, according to FAF

For this study, Transearch data are only available for Arizona, making it difficult to benchmark Pima County's production of Advanced Products relative to comparator cities. However, FAF data are available for nearly almost all of the MAP Dashboard cities (with the exceptions of Colorado Springs, CO, and Albuquerque, NM).

Figure 5-5 shows a breakdown of MAP Dashboard cities on the basis of Advanced Products outflows (defined as flows destined for outside of the same FAF region). It should be noted that FAF and Transearch data may not align perfectly due to differences in categorizing commodities (STCC vs. SCTG codes) and geographic definitions (Tucson FAF region includes Cochise and Santa Cruz counties). Nonetheless, the FAF results for outbound Advanced Products are of a similar magnitude in the FAF data, with Tucson at $5.1 b. and Phoenix at $27.6 b.

Figure 5-5: Outbound Advanced Products Flows for MAP Dashboard Cities (FAF Data)

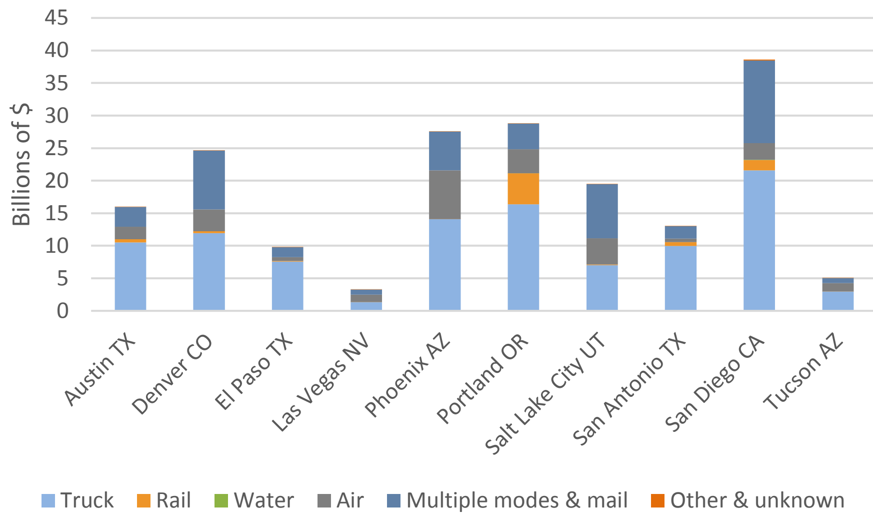


Source: CPCS analysis of FAF data (2013). Note: Outbound means destined outside of the same FAF region. Does not include foreign-origin products whose domestic origin is the region at hand (i.e., Tucson does not include imports with domestic origin as the Tucson BEA region).

FAF does not have as much granularity in terms of commodities compared with Transearch. Nonetheless, five types of products can be categorized as Advanced Products. Tucson's Advanced Products outflows are larger than Las Vegas's but lower than the other comparator cities'. The cities with the top outflows are San Diego, Portland, and Phoenix.

Figure 5-6 shows a similar breakdown on the basis of mode. It reveals that 59% of Tucson's outflows are by truck, which is in line with the average across all the cities (57%). However, in absolute terms, the volume of truck and air activity outbound from Tucson is relatively low.

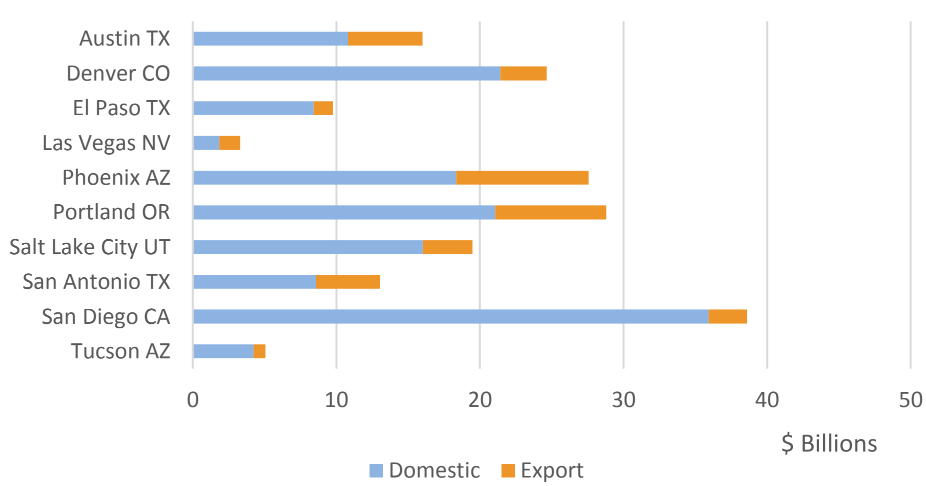
Figure 5-6: Outbound Advanced Products Flows for MAP Dashboard Cities, by Mode (FAF Data)



Source: CPCS analysis of FAF data (2013). Note: Outbound means destined outside of the same FAF region. Does not include foreign-origin products whose domestic origin is the region at hand (i.e., Tucson does not include imports with domestic origin as the Tucson BEA region).

Figure 5-7 shows a final perspective for outbound advanced product flows: the share of domestic versus exported outflows. Tucson's absolute volume of exported outflows is under $1 b., which is lower than the other MAP Dashboard cities' volumes. In percentage terms, Tucson exports 16% of its outflows, which is higher than El Paso, Denver, and San Diego. Phoenix's exports are 33% of its Advanced Products outflows.

Figure 5-7: Outbound Advanced Products Flows for MAP Dashboard Cities, Exports vs. Domestic (FAF Data)



Source: CPCS analysis of FAF data (2013). Note: Outbound means destined outside of the same FAF region. Does not include foreign-origin products whose domestic origin is the region at hand (i.e., Tucson does not include imports with domestic origin as the Tucson BEA region).

5.2.4 Conclusions

Compared with MAP Dashboard cities, Tucson has relatively low levels of Advanced Products outflows, although it should be emphasized that Colorado Springs and Albuquerque do not have available data from FAF, which may skew the results somewhat.

Overall, Tucson's performance on Advanced Products outflows is highly dependent on whether one considers missiles. Pima County's out-of-state flows of Advanced Products are $2.7 b., compared with $6.7 b. in missile products. Thus, if the missiles were also considered to be exported from the state, their share of all such out-of-state exports would be 71%, easily overshadowing all other Advanced Products outflows.

This analysis reaffirms the importance of missile production for the region's high-tech economy. However, it also suggests that the region should seek to further diversify, including by growing exports of other high-tech products.

Export flows to Mexico are fairly high for Tucson in relative terms. Most of these are to Sonora and Chihuahua rather than further afield.

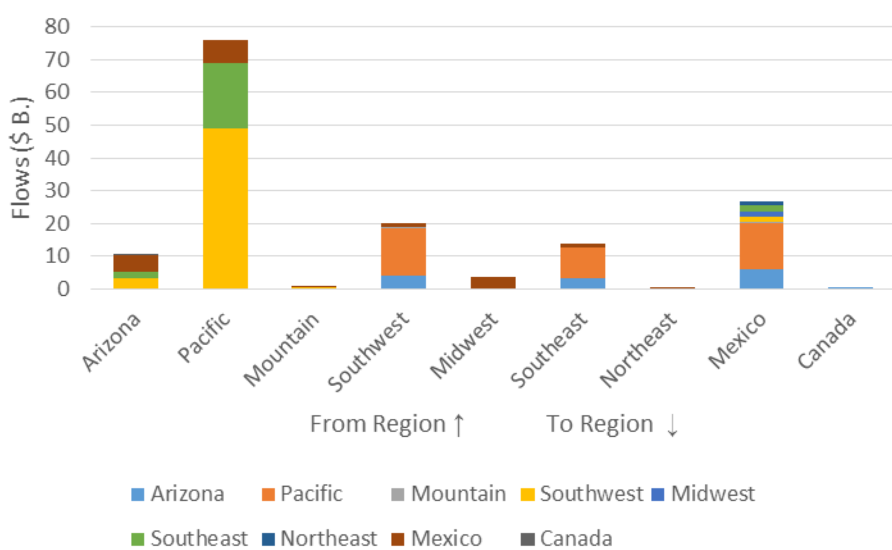
5.3 Focus On: Pass-Through Flows

Using GIS capabilities, the study team mapped Transearch truck flows that pass through Pima County. Most of these are flows along I-10 or I-19.

5.3.1 Origins and Destinations of Pass-Through Truck Flows

Figure 5-8 shows the origins and destinations of truck flows, in billions of dollars. Origin regions are listed along the bottom axis of the chart, while destination regions are displayed by color. As can be seen in the graph, the single largest origin-destination (OD) pair is flows from the Pacific region to the Southwest. Overall, $76 b. of flows originating in the Pacific region pass through Pima County.

Figure 5-8: Origins and Destinations of Truck Flows Passing Through Pima County

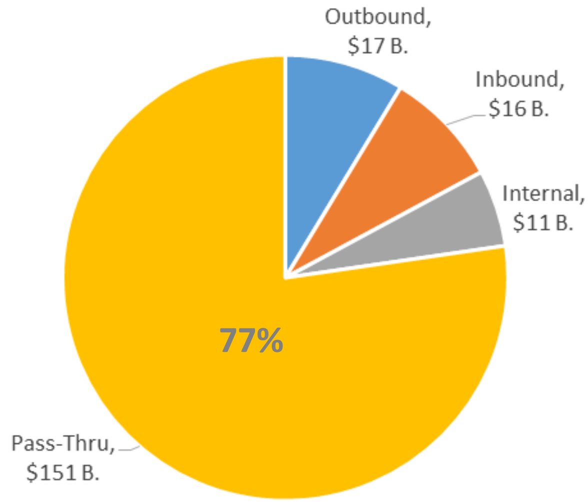


Source: CPCS analysis of Transearch data (2013)

In total, the $76 b. of pass-through flows originating in the Pacific region represent approximately half of the $151 b. in total pass-through flows.

For reference, the $151 b. in pass-through truck flows is equal to 77% of all truck flows in the region (Figure 5-9).

Figure 5-9: Truck Through-Flows as a Share of All Truck Flows in Pima County

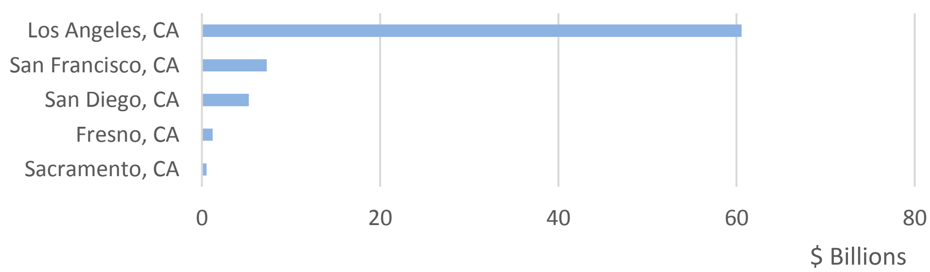


Source: CPCS analysis of Transearch data (2013)

Domestic Flows from Los Angeles

Figure 5-10 further breaks down the Pacific region: the Los Angeles economic area is by far the most significant origin for through-flows passing through Pima County.

Figure 5-10: Top Origin BEA Areas within Pacific Region, for Pass-Through Flows Through Pima County

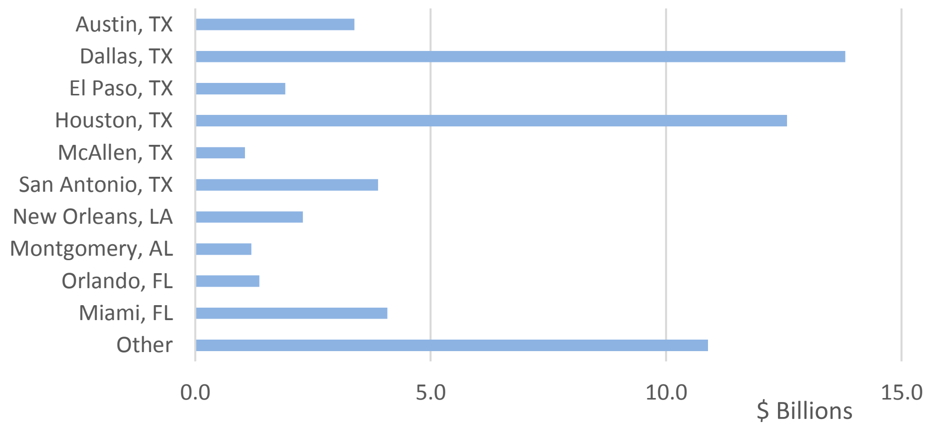


Source: CPCS analysis of Transearch data (2013). City listed is the BEA economic area as defined by the Bureau of Economic Analysis.

Collectively, $60 b. of flows pass through Pima County from Los Angeles to domestic destinations.

Figure 5-11 shows the top destination areas for domestic flows from Los Angeles. The top destinations are located in the Southwest and Southeast, notably Dallas and Houston, along with Miami, San Antonio, and Austin. Truck trips from Los Angeles to Texas alone account for over $35 b. of pass-through flows.

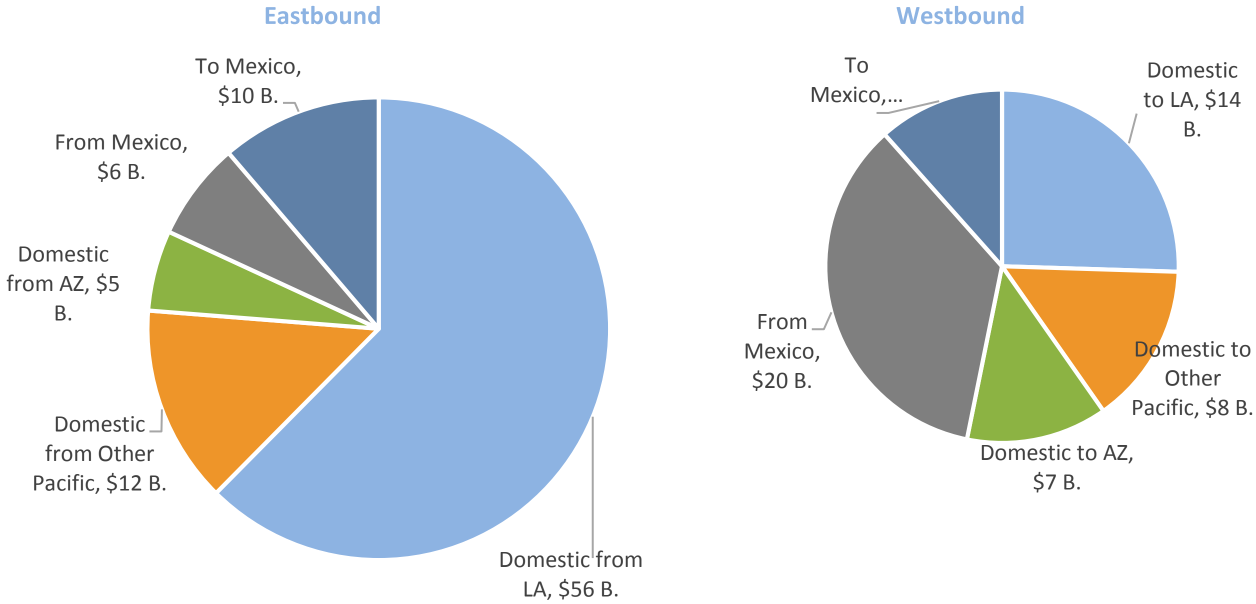
Figure 5-11: Top Destinations for Domestic flows from Los Angeles BEA Area



Source: CPCS analysis of Transearch data (2013). City listed is the BEA economic area as defined by the Bureau of Economic Analysis.

Taking into account the importance of Los Angeles for pass-through flows in Pima County, Figure 5-12 shows a simplified depiction of the origins and destinations of truck flows passing through Pima County. The geographic categories are distilled into five “flow paths” for each direction.

Figure 5-12: Simplified Flow Paths Through Pima County



Source: CPCS analysis of Transearch data (2013). For greater clarity, eastbound to Mexico includes flows to Mexico originating in Arizona, Pacific, or Mountain regions. Eastbound from Mexico includes flows from Mexico to the Southwest, Midwest, Southeast, and Northeast regions. The reverse is true for westbound cross-border flows.

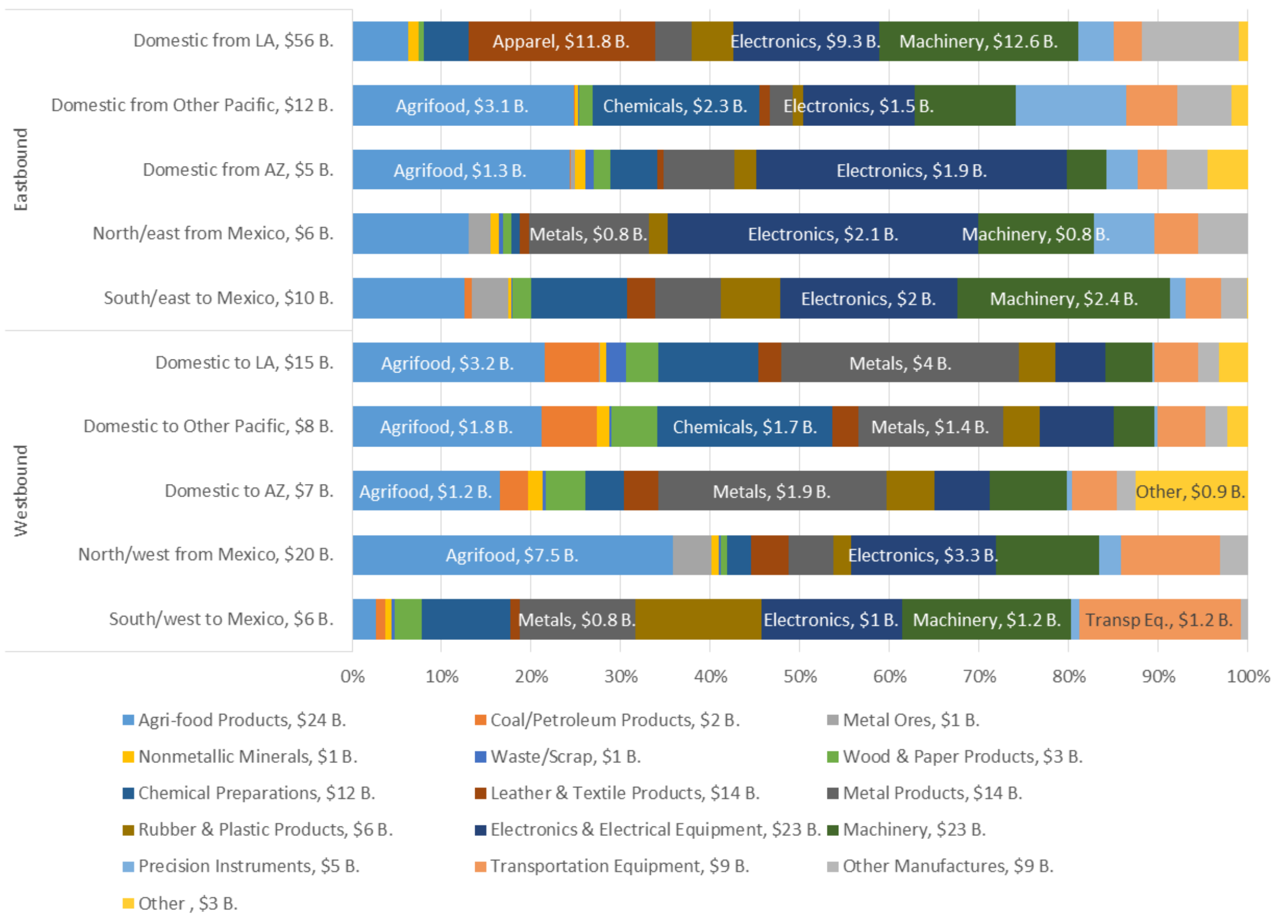
As indicated by the figure:

- $56 b. of flows are domestic flows originating in the Los Angeles area.
- Among the remaining eastbound flows, $17 b. originate elsewhere in Arizona (including the Phoenix area) or elsewhere in the Pacific region (such as San Francisco or San Diego). $18 b. are cross-border flows to or from Mexico.
- Among westbound flows, $26 b. are cross-border flows to/from Mexico (mostly from Mexico to Arizona or the Pacific), while $14 b. are domestic flows to the LA area and $15 b. are domestic flows to Arizona or elsewhere in the Pacific.
- Overall, there is a directional imbalance with $93 b. flowing eastbound through Pima County and $58 b. flowing westbound. Most of this imbalance is explained by truck flows from the Los Angeles area, presumably largely from the Ports of Long Beach and Los Angeles, to domestic destinations in the Southwest and, to a lesser extent, the Southeast.

5.3.2 Truck Pass-Through Commodities

Figure 5-13 shows the commodity breakdown by flow path. For many flow paths, the top commodities include electronics, machinery, metals, and agri-food products. Apparel (Leather and Textile Products) is also significant for the "Domestic from Los Angeles" category.

Figure 5-13: Top Commodities by Flow Path

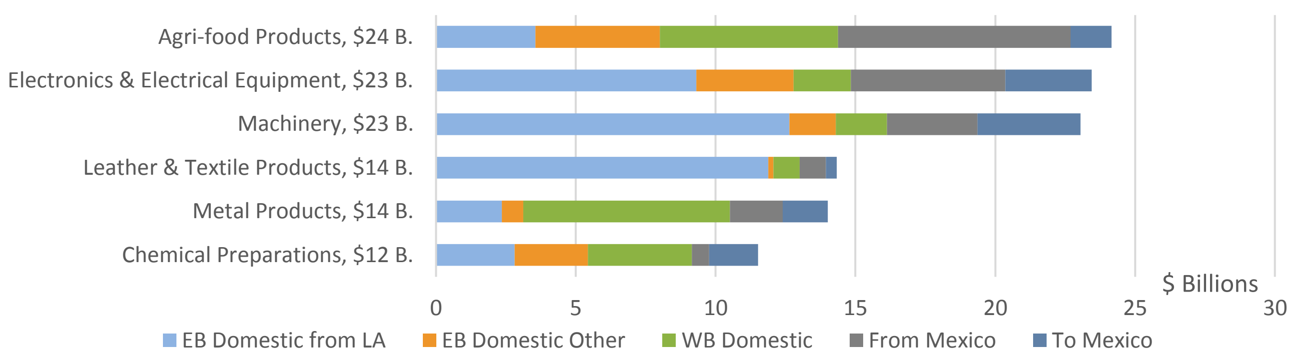


Source: CPCS analysis of Transearch data (2013)

Figure 5-14 shows the top commodities passing through Pima County, for all origins and destinations. The top commodity categories are agri-food products, electronics, machinery, leather and textile (apparel), metals, and chemicals.

As corroborated by Figure 5-13, the top commodities for all flow paths are not necessarily identical. For example, there is very little in apparel flows outside of the "LA to domestic" market. Machinery also tends to move eastbound from Los Angeles. On the other hand, Metal Products tend to move in the reverse direction. Agri-food Products tend to be balanced, with Mexican-origin flows representing a significant portion of these flows.

Figure 5-14: Top Commodities Passing Through Pima County



Source: CPCS analysis of Transearch data (2013)

5.3.3 Top Pass-Through Commodities in Greater Detail

Each of the top pass-through commodity categories for truck flows is explored in greater detail, in terms of the detailed commodity and simplified origin/destination. The Detailed Commodity category is the finest level of aggregation available through Transearch, representative of four-digit STCC codes.

Agri-food Products

Figure 5-15 shows the top Agri-food Products passing through Pima County.

Figure 5-15: Top Agri-food Commodities Passing Through Pima County

Detailed Commodity	Value ($M.)	From LA	From PAC	From AZ	To LA	To PAC	To AZ	From MEX	To MEX	Other
		Eastbound			Westbound			Cross-Bord.		
Misc. Fresh Vegetables	$2,417	7%	1%	4%	1%	0%	0%	86%	0%	0%
Tropical Fruits	$2,371	0%	0%	0%	0%	5%	1%	93%	0%	0%
Wine, Brandy or Brandy Spirit	$1,935	28%	71%	1%	0%	0%	0%	0%	0%	0%
Misc. Fresh Fruits or Tree Nuts	$1,449	17%	10%	0%	2%	0%	0%	70%	0%	0%
Deciduous Fruits	$1,220	12%	36%	2%	0%	0%	0%	24%	27%	0%
Cotton, raw	$1,168	1%	0%	4%	93%	1%	0%	0%	1%	0%
Processed Poultry or Eggs	$1,058	0%	0%	0%	52%	25%	23%	0%	0%	1%
Misc. Food Preparations, Nec.	$910	29%	6%	11%	1%	1%	1%	29%	22%	1%
Leafy Fresh Vegetables	$901	72%	10%	0%	0%	0%	0%	18%	0%	0%
Bread or Other Bakery Prod	$728	53%	22%	15%	3%	2%	3%	0%	0%	2%
Fresh Fish or Whale Products	$683	30%	20%	0%	5%	4%	3%	37%	0%	0%
Soft Drinks or Mineral Water	$668	28%	7%	24%	5%	4%	2%	23%	5%	2%
Malt Liquors	$657	13%	27%	12%	0%	0%	0%	35%	11%	1%
Dressed Poultry, Fresh	$481	0%	0%	0%	53%	19%	23%	0%	3%	1%
Meat Products	$478	1%	0%	0%	37%	30%	25%	1%	1%	6%
ALL AGRI-FOOD PRODUCTS	**$23,715**	**15%**	**13%**	**4%**	**14%**	**8%**	**5%**	**35%**	**6%**	**1%**

Source: CPCS analysis of Transearch data (2013). Note: LA = Los Angeles BEA economic area; PAC = Pacific BEA region (exclusive of Los Angeles)

As shown in the graph, 35% of Agri-food Products passing through Pima County originate in Mexico, notably including fresh vegetables and fruit. Top eastbound commodities include fruit and vegetables from California, bread/bakery products, and alcoholic beverages. Top westbound commodities include cotton and meat/poultry products.

Drilling further into the Transeach data reveals that the Mexico-origin fruit and vegetables are primarily destined to Maricopa County (in the case of fresh vegetables), as well as to the San Francisco and Los Angeles areas.

The top origins for cotton are Georgia, West Texas, and New Mexico, while the top origin areas for meat/poultry products are Houston and Dallas in Texas, along with the Jackson, MS, area.

Electronics and Electrical Equipment

Figure 5-16 shows the top Electronics & Electrical Equipment commodities passing through Pima County.

Figure 5-16: Top Electronics and Electrical Equipment Commodities Passing Through Pima County

Detailed Commodity	Value ($M.)	From LA	From PAC	From AZ	To LA	To PAC	To AZ	From MEX	To MEX	Other
		Eastbound			Westbound			Cross-Bord.		
Solid State Semiconductors	$4,003	45%	7%	27%	4%	4%	1%	2%	9%	0%
Radio or TV Transmitting Eq.	$2,922	36%	4%	2%	5%	2%	3%	24%	24%	0%
Misc. Electrical Industrial Eq.	$2,026	41%	22%	24%	2%	2%	2%	3%	5%	0%
Radio or TV Receiving Sets	$1,927	36%	2%	0%	0%	0%	0%	46%	16%	0%
Elec Eq. For Intern Comb Engine	$1,732	10%	0%	1%	3%	1%	1%	79%	5%	0%
Current Carrying Wiring Eq.	$1,614	12%	1%	1%	2%	0%	0%	73%	11%	0%
Lighting Fixtures	$1,222	81%	5%	1%	1%	1%	1%	9%	2%	0%
Motors or Generators	$1,158	43%	2%	0%	4%	1%	1%	30%	20%	0%
Misc. Electronic Components	$921	30%	19%	14%	7%	5%	3%	6%	16%	0%
Household Cooking Equipment	$799	94%	0%	0%	0%	2%	0%	3%	0%	0%
Electric Measuring Instruments	$730	18%	34%	5%	4%	19%	9%	10%	3%	0%
ALL ELECTRONIC & ELECTRICAL	**$23,470**	**40%**	**7%**	**8%**	**4%**	**3%**	**2%**	**24%**	**13%**	**0%**

Source: CPCS analysis of Transearch data (2013). Note: LA = Los Angeles BEA economic area; PAC = Pacific BEA region (exclusive of Los Angeles)

The top cross-border commodities in this category include televisions/related equipment as well as motors and motor vehicle equipment. Eastbound flows are largely from the Los Angeles area and include household products as well as industrial electrical equipment. Semiconductors (including those relating to the Phoenix high-tech economy) are another significant through-flow. Westbound flows of electronics and electrical equipment are fairly minimal.

Machinery

Figure 5-17 shows the top Machinery products passing through Pima County.

Figure 5-17: Top Machinery Commodities Passing Through Pima County

Detailed Commodity	Value ($M.)	From LA	From PAC	From AZ	To LA	To PAC	To AZ	From MEX	To MEX	Other
		Eastbound			Westbound			Cross-Bord.		
Electronic Data Proc. Equipment	$8,458	77%	7%	0%	1%	0%	0%	5%	10%	0%
Industrial Pumps	$2,284	53%	1%	0%	2%	0%	0%	9%	34%	0%
Constr. Machinery or Eq.	$950	13%	2%	3%	6%	8%	11%	7%	49%	0%
Accounting or Calculating Eq.	$933	49%	33%	4%	1%	0%	0%	0%	12%	0%
Commercial Laundry Equipment	$883	94%	0%	0%	0%	0%	0%	1%	4%	0%
Oil Field Machinery or Eq.	$772	2%	0%	0%	46%	12%	36%	0%	1%	2%
Metalworking Machinery	$725	45%	0%	2%	0%	1%	0%	47%	5%	0%
Misc. Office Machines	$654	2%	0%	0%	0%	0%	0%	86%	11%	0%
Refrigeration Machinery	$651	20%	0%	1%	7%	5%	7%	42%	18%	1%
ALL MACHINERY	**$23,051**	**55%**	**6%**	**1%**	**3%**	**2%**	**3%**	**14%**	**16%**	**0%**

Source: CPCS analysis of Transearch data (2013). Note: LA = Los Angeles BEA economic area; PAC = Pacific BEA region (exclusive of Los Angeles)

Cross-border machinery flows include office and industrial machinery going to Mexico, and construction and industrial equipment destined for the United States. Eastbound flows are predominantly from the Los Angeles area and include consumer products such as computers and industrial machinery such as pumps. The top westbound commodity is oil-field machinery, predominantly originating in the Houston area and destined for Los Angeles and Pinal County.

Leather and Textile Products

Figure 5-18 shows top leather & textile commodities passing through Pima County.

Figure 5-18: Top Leather & Textile Commodities Passing Through Pima County

Detailed Commodity	Value ($M.)	From LA	From PAC	From AZ	To LA	To PAC	To AZ	From MEX	To MEX	Other
		Eastbound			Westbound			Cross-Bord.		
Women's or Children's Clothing	$5,863	90%	1%	0%	1%	0%	1%	5%	2%	0%
Leather Footwear	$2,888	93%	0%	0%	3%	1%	0%	2%	0%	0%
Men's or Boys' Clothing	$1,639	75%	1%	0%	2%	1%	3%	17%	1%	0%
Leather Luggage or Handbags	$1,494	97%	1%	0%	0%	0%	1%	0%	0%	0%
ALL LEATHER & TEXTILE	**$14,286**	**83%**	**1%**	**0%**	**3%**	**2%**	**2%**	**7%**	**3%**	**0%**

Source: CPCS analysis of Transearch data (2013). Note: LA = Los Angeles BEA economic area; PAC = Pacific BEA region (exclusive of Los Angeles)

The vast majority of pass-through flows in this category are from the LA area, with a small percentage from Mexico. The top destinations are large southern cities such as Dallas, Houston and San Antonio.

Metal Products

Figure 5-19 shows the top Metal Products passing through Pima County.

Figure 5-19: Top Metal Products Commodities Passing Through Pima County

Detailed Commodity	Value ($M.)	From LA	From PAC	From AZ	To LA	To PAC	To AZ	From MEX	To MEX	Other
		Eastbound			Westbound			Cross-Bord.		
Misc. Prim. Nonferr. Smelter Pr.	$4,196	1%	0%	0%	60%	8%	30%	0%	0%	0%
Primary Iron or Steel Products	$1,405	0%	0%	0%	24%	30%	18%	8%	16%	4%
Nonferrous Wire	$1,113	0%	0%	1%	6%	2%	2%	58%	32%	0%
Bolts, Nuts, Screws, etc.	$701	75%	10%	3%	0%	1%	1%	0%	9%	0%
Aluminum or Alloy Basic Shapes	$599	45%	0%	20%	0%	0%	1%	3%	30%	0%
Valves or Pipe Fittings	$542	36%	1%	8%	5%	6%	1%	28%	15%	0%
ALL METAL PRODUCTS	**$14,127**	**17%**	**2%**	**3%**	**28%**	**10%**	**14%**	**13%**	**11%**	**1%**

Source: CPCS analysis of Transearch data (2013). Note: LA = Los Angeles BEA economic area; PAC = Pacific BEA region (exclusive of Los Angeles)

Miscellaneous primary nonferrous smelter products are destined primarily for Los Angeles or Maricopa County, from locations in Alabama and Louisiana. Primary iron or steel products largely originate in the Houston area and are destined for Arizona or California.

Chemical Preparations

Figure 5-20 shows the top chemical products passing through Pima County.

Figure 5-20: Top Chemical Preparations Commodities Passing Through Pima County

Detailed Commodity	Value ($M.)	From LA	From PAC	From AZ	To LA	To PAC	To AZ	From MEX	To MEX	Other
		Eastbound			Westbound			Cross-Bord.		
Drugs	$2,678	34%	61%	3%	0%	0%	0%	1%	0%	0%
Misc. Industrial Organic Chem.	$1,930	34%	29%	7%	14%	0%	0%	2%	13%	1%
Misc. Industrial Inorganic Chem.	$1,797	0%	0%	0%	31%	50%	0%	2%	16%	0%
Plastic Mater. or Synth. Fibres	$1,657	31%	6%	0%	17%	4%	0%	9%	32%	0%
Cosmetics, Perfumes, etc.	$761	80%	2%	3%	2%	3%	3%	5%	4%	0%
ALL CHEMICAL PREPARATIONS	**$11,590**	**24%**	**20%**	**3%**	**15%**	**15%**	**2%**	**5%**	**15%**	**1%**

Source: CPCS analysis of Transearch data (2013). Note: LA = Los Angeles BEA economic area; PAC = Pacific BEA region (exclusive of Los Angeles)

Chemical flows are balanced geographically. High-value products such as drugs (pharmaceuticals) and cosmetics tend to move through west-to-east, while industrial chemical products move westbound as well as cross-border to Mexico.

5.3.4 Pass-Through Rail Flows

Rail flows from Mexico entering Santa Cruz County and destined beyond Tucson total $8.2 b., while rail flows in the other direction are worth $0.8 b.. The discrepancy is explained by $6.5 b. in motor vehicle flows from Sonora, mostly destined for the Midwest. Total pass-through flows to/from Mexico are shown in Figure 5-21. Aside from motor vehicles, there are nearly $1 b. in Agri-food Products (bi-directionally), and a similar magnitude of Chemical Preparations (mostly inbound).

Figure 5-21: Top Commodity Categories Passing Through Pima County to/from Mexico ($M.)

Commodity Category	From Mexico	To Mexico
Transportation Equipment	$6,497	$40
Motor Vehicles	$6,497	$38
Agri-food Products	$503	$359
Marine Fats or Oils	$277	
Malt Liquors	$204	
Soybean Oil or By-products		$121
Distilled or Blended Liquors		$94
Chemical Preparations	$814	$52
Misc. Industrial Inorganic Chemicals	$814	
Metal Products	$352	$256
Primary Copper Smelter Products	$342	$187
Metal Ores	$53	$0
Copper Ores	$53	

Source: CPCS analysis of Transearch data (2013)

Among flows north from Mexico, half the malt liquor products are destined for the west coast, with the other half heading east. The marine fats are destined largely for the north (notably Idaho) as well as east. The vast majority of industrial chemicals are destined for Phoenix. The primary copper smelter products are destined east for points such as Atlanta and New York.

Among flows south to Mexico, Agri-food Products including distilled/blended liquors and soybeans oil/by-products, are largely originating in the Upper Midwest, such as Iowa, Nebraska, and Minnesota. The primary copper smelter products originate in Phoenix.

Since the Transearch data list the origin/destination as Santa Cruz County, there is no visibility into origins/destinations on the Mexico side.

5.3.5 Commodities with Geographic Balance

An initial step in judging Tucson's competitiveness as a logistics hub is to look at the geographic balance of commodities flowing through the region. Supply chains that are strictly linear are likely less conducive to value-added activities or transloading. Some supply chains (such as the $14 b. in apparel that flows through the region) are almost exclusively directed from Los Angeles to markets in the Southwest. Tucson is unlikely to serve as more than a pass-through point for these types of flows.

The study team examined the geographic origins and destinations of all commodities passing through the Tucson region. For the purposes of this analysis, "West" was defined as the Pacific region and Arizona (minus Pima, Cochise, and Santa Cruz Counties); "East" was defined as the Southwest, Southeast, Midwest, and Northeast regions in the United States; and "South" was defined as the Mexican state of Sonora.

Figure 5-22 shows the top commodities moving in each of three paths: east-west, south-west, and south-east (or reverse). The commodities are ordered by the minimum-path flow volume. Interestingly, most of the top-ranked commodities are industrial parts and products. For many Agri-food Products, there are significant flows from south-to-west and west-east but not going south-east.

Figure 5-22: Pass-Through Commodities with Geographic Balance in Origins-Destinations ($M)

Commodity	East-West / West-East	South-West / West-South	South-East / East-South
Misc. Plastic Products	$1,917	$332	$444
Elec Eq. For Intern Comb Engine	$267	$448	$367
Current Carrying Wiring Equipment	$242	$514	$518
Motor Vehicle Parts or Accessories	$589	$212	$882
Radio or TV Transmitting Equipment	$1,528	$377	$179
Misc. Fresh Vegetables	$233	$1,710	$174
Mech. Measuring or Control Equipment	$291	$152	$183
Metalworking Machinery	$349	$174	$151
Nonferrous Wire	$111	$338	$336
Constr. Machinery or Equipment	$415	$102	$340
Surgical or Medical Instruments	$486	$98	$146
Misc. General Industrial	$196	$93	$99
Motor Vehicles	$773	$93	$162
Industrial Pumps	$1,307	$78	$81
Tires or Inner Tubes	$432	$67	$277
Electrical Transformers	$175	$65	$74
Industrial Trucks, Etc.	$61	$199	$175
Steam Engines, Turbines, Etc.	$192	$81	$61
Radio or TV Receiving Sets	$734	$55	$213
Misc. Electronic Components	$713	$105	$54
Storage Batteries or Plates	$108	$69	$52
Chemical Preparations, Nec	$221	$52	$92
Misc. Indus Inorganic Chemicals	$1,468	$49	$205
Soap or Other Detergents	$230	$48	$49
Fresh Fish or Whale Products	$426	$202	$48
Motors or Generators	$584	$78	$47
Solid State Semiconductors	$3,553	$154	$46
Switchgear or Switchboards	$46	$63	$269

Source: CPCS analysis of Transearch data (2013).

5.3.6 Conclusions

Pass-through truck flows are large, at 77% of all flows in the Tucson region (including inbound, outbound, and internal). Approximately half the pass-through flows are domestic flows from the Pacific (especially the Los Angeles area, including the port of Los Angeles and Long Beach) to consumers in the Southwest (including Texas) and Southeast.

Although metrics on pass-through flows relative to total flows are not readily available for other metropolitan areas, the large volume of pass-through traffic is not necessarily unexpected for a region straddling a major interstate corridor like I-10.

The top pass-through commodity categories by truck are Agri-food Products, Electronics, Machinery, Leather and Textile (apparel), Metals, and Chemicals. Some of these, such as apparel, are very linear in their flows, with 83% of all apparel pass-through flows destined from the Los Angeles area to domestic destinations east of Tucson (such as Texas).

An analysis was performed to reveal commodities with geographic balance in their origins and destinations, including south to Mexico, west to Phoenix/California, and east to Texas and beyond. Many of the commodities with the most geographic balance are industrial parts and products.

Future studies could explore some of these supply chains in greater depth, in terms of their amenability to logistics hub/cluster-type activity in the Tucson region. This would involve further examining the geographic and broader competitive advantages and disadvantages of Tucson relative to Phoenix, which has a larger population and larger freight base and is more central and connected in some respects; as well as Nogales, which is directly at the border. One way or another, much of Tucson’s opportunity to have logistics hub-type functions will likely be dependent on flows with Mexico to the south.

6 Conclusions

Key Chapter Takeaway

- Missiles are a major contributor to the regional economy, and their share of Advanced Products outflows is high. Tucson is also home to "Optics Valley," a cluster of optics companies. Continuing to take advantage of linkages with the University of Arizona, as well as developing the talent pipeline overall, are important for growing a diversified export economy in advanced manufacturing, and increasing the number of high-paying jobs that come with it.
- Future studies could build on this work to reveal specific high-tech industries that could be expanded, potential untapped/underutilized markets for outbound products, and potential supply chains that may be amenable to value-added or distribution-related facilities in the Tucson Region

6.1 Conclusions

This study paints a picture of commodity flows in the Tucson region (Pima County).

Missiles are a major contributor to the regional economy, and their share of Advanced Products outflows, at 71%, is quite high. Transportation Equipment manufacturing (including missiles) are also the major reason for Tucson scoring well, compared with comparator cities in manufacturing payroll per employee, as well as in manufacturing activity. Unfortunately, due to the sensitive nature of the commodity, missile flows are not completely clear in the sense that their domestic and foreign destinations are not known (the Transearch data indicate the shipments as being destined within Tucson, likely reflecting a lack of visibility beyond when they are handed over to the military). In spite of these shortcomings, analysis of Raytheon's annual reports, publically available data on its employment in the city, and other sources would certainly support the view that missile-related production is the primary driving force behind advanced product outflows in the region.

Although these findings reaffirm the importance of missile production to the region, they are also an argument for increased diversification. Tucson and southern Arizona are home to "Optics Valley," a cluster of optics companies, many of which have grown out of research at the University of Arizona. The regional Economic Blueprint Update emphasizes the importance of continuing to support diversified advanced manufacturing, build the talent pipeline, and focus on education as a means of growing a highly skilled workforce.

Tucson has a very low share of transportation and logistics-related activities, ranking at or near the bottom among comparator cities. Tucson is not located centrally within the United States, and the majority of U.S. trade with Mexico passes through Texas border crossings, notably Laredo. Nonetheless, Tucson's attractiveness is improved when one considers the proximity to Sonora across the southern border. There is a large amount of pass-through truck traffic through Tucson (equal to 77% of all truck traffic, including outbound, inbound, and internal), though much of this is linear between Los Angeles (including the ports of Los Angeles and Long Beach) and destinations in the Southwest and Southeast. This study highlights some of the commodities with more balanced origin-destination routes, for which Tucson may be strategically located. Many of these commodities are related to industrial parts and products.

Future studies could build on this work to reveal specific high-tech industries that could be expanded in Tucson, potential untapped/underutilized markets for outbound products, and potential supply chains that may be amenable to value-added or distribution-related facilities in the Tucson Region.

Appendix A

Figure 6-1: Commodity Group Definitions

Commodity Group	STCC Codes (Transearch)	STCG Codes (FAF)
Basic Products		
Agri-food Products	01, 08, 09, 20, 21	01– 09
Coal/Petroleum Products	11, 13, 29	15 – 19
Metal Ores	10	14
Nonmetallic Minerals	14, 32,	10 – 13, 31
Waste/Scrap	40	41
Wood & Paper Products	24, 26, 27	25 –29
Intermediate Products		
Chemical Preparations	28	20 – 23
Leather & Textile Products	22, 23, 31	30
Metal Products	33, 34	32 – 33
Rubber & Plastic Products	30	24
Advanced Products		
Electronics & Electrical Eq.	36	35
Machinery	35	34
Precision Instruments	38	38
Transportation Equipment	37	36, 37
Other		
Empty Equipment	42	N/A
Other Manufactures	19, 25, 39	39, 40, 43
Other	41, 43, 45, 46, 47, 50	N/A

Appendix 2

Regional Freight Corridors Performance Analysis

A major outcome of the PAG Regional Freight Plan is the identification of the Regional Freight Corridors (RFC) network, a subsystem of roadways that is particularly important to the movement of goods into and out of the region. The RFC network was determined using a multifactor process that involved discussion with the region's jurisdictions and freight stakeholders, analysis of truck volume and commodity flow data, and consideration of connections to intermodal freight facilities and other known significant freight generators.

Following the identification of the RFCs, PAG conducted an analysis of the network to evaluate freight performance. This analysis compares performance between the RFC network and other parts of the road system and provides information on individual corridor segments.

For the network-scale comparison, the analysis was limited to observed performance of truck delay (TTI – Travel Time Index) and truck reliability (PTI – Planning Time Index).[1] As shown in **Table 1**, trucks traveling on the RFC network experience greater delay (TTI) and less reliable travel conditions (PTI) than those on the region's interstate highways, as expected. Comparing RFCs with the entire non-interstate network, on the other hand, reveals that trucks experience somewhat less delay on the RFC network, but more unreliable travel conditions. The overall system is performing within acceptable thresholds in terms of recurring truck delay and reliability.

Table 1 Comparison of freight truck delay and reliability on regional roadways

Road network	TTI	PTI
Overall	1.09	1.26
Interstate	1.06	1.15
Non-interstate	1.45	2.80
Regional Freight Corridors	**1.28**	**2.97**

Source: PAG analysis of ATRI truck GPS data

For the corridor-segment analysis, PAG introduced three additional factors for consideration beyond truck reliability and delay. These included current roadway congestion, future congestion predicted for 2045, and condition of bridge structures on the segments.

[1] TTI and PTI performance was derived from 2016 ATRI truck GPS data covering 16 weeks. For a full discussion of TTI and PTI, refer to Chapter 3 of the PAG Regional Freight Plan.

The five factors were considered both individually and combined to produce a Composite Freight Performance Score for every segment of the RFC network. The score was created by assigning a point value for each factor based on predetermined thresholds (3 for Good, 2 for Fair, and 1 for Poor) and summing the total for the roadway segment. This process was used to identify current and emerging freight issues and determine whether there are projects in the planning pipeline to address the issues.

Truck Travel Delay

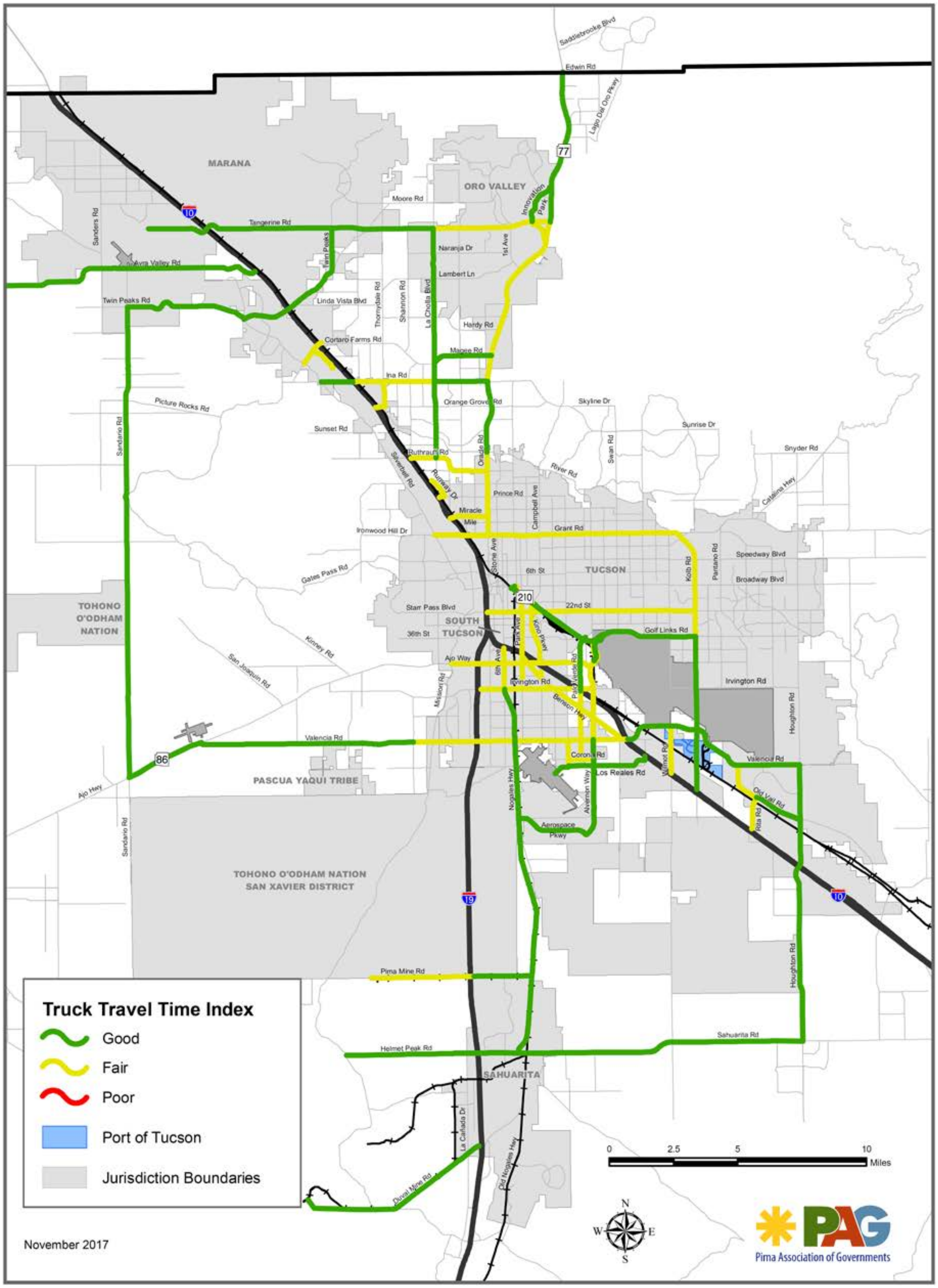
The first factor considered in developing the Composite Freight Performance Score was the truck TTI. Truck TTI measures recurring freight delay on corridor segments during peak hour, based on the difference in travel time between free-flow conditions and normal peak-hour conditions. The thresholds used to determine performance (**Table 2**) are the same as used by the Arizona Department of Transportation (ADOT) in the *I-19 Corridor Profile Study*.

Table 2 Travel Time Index performance thresholds

Performance Consideration	Measure	Value	Performance Rating	Performance Score
Recurring truck peak-hour delay	Truck Travel Time Index	<1.3	Good	3
		1.3–2.0	Fair	2
		>2.0	Poor	1

Figure 1 shows truck TTI on the RFC network. Performance ranges from “Fair” on more urban segments to “Good” on suburban and rural segments, indicating overall adequate performance in terms of recurring truck delay (**Figure 1**).

Figure 1 Truck Travel Time Index on Regional Freight Corridors (2016)



Truck Travel Time Reliability

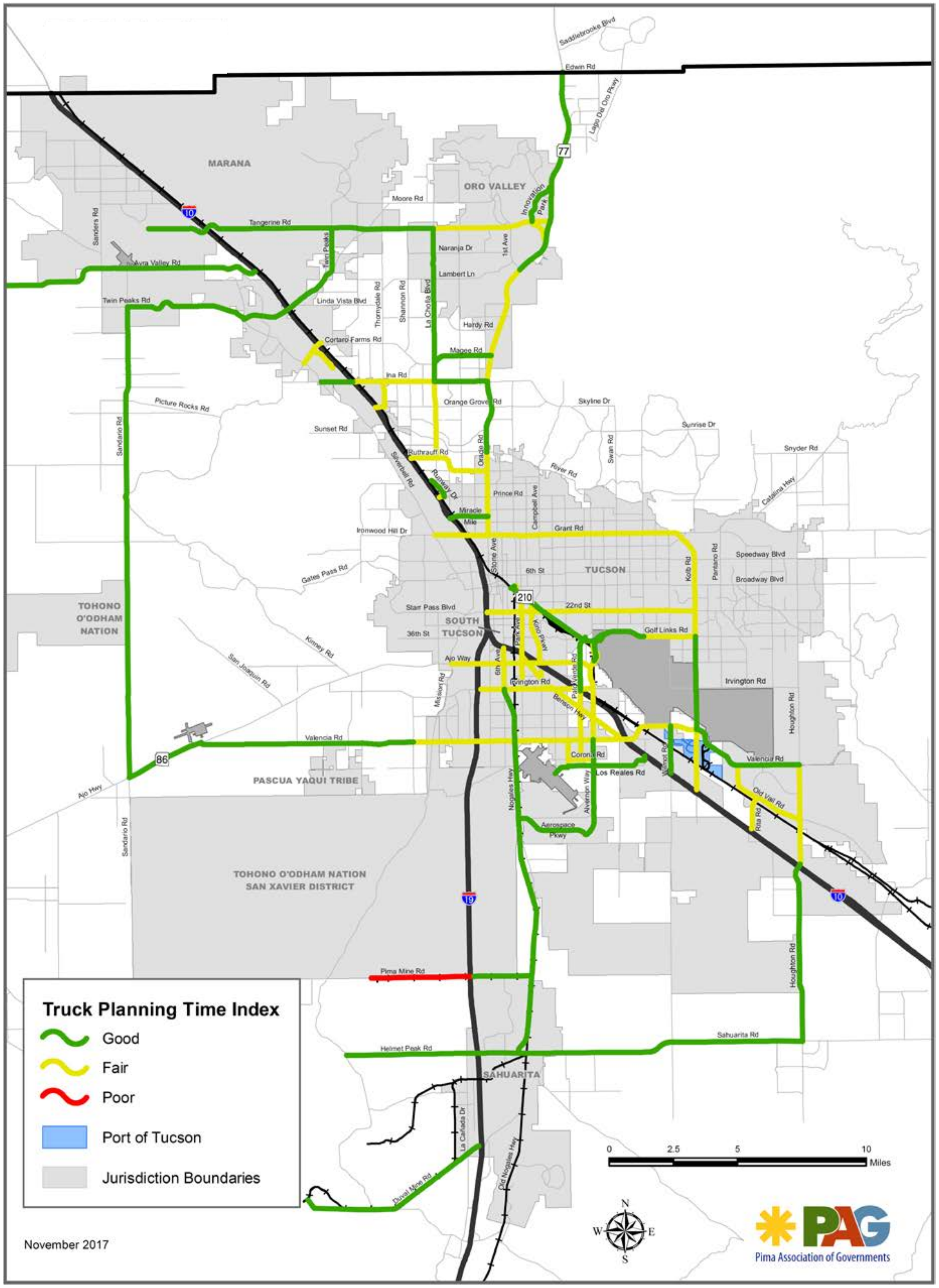
The second factor considered in the performance assessment was truck travel time reliability as measured by truck PTI. PTI measures the difference between the observed 95th percentile travel time on a given segment and free-flow travel times. The difference between these two numbers shows what travelers can expect as the worst travel time on a given segment, usually resulting from construction, accidents or other sporadic events. The higher the number, the greater the travel-time disparity between free-flow and the worst observed travel times. Thresholds were again derived from the ADOT *I-19 Corridor Profile Study* (**Table 3**).

Table 3 Truck Planning Time Index performance thresholds

Performance Consideration	Measure	Value	Performance Rating	Performance Score
Truck travel time reliability	Truck Planning Time Index	<3.0	Good	3
		3.0–6.0	Fair	2
		6.0	Poor	1

Like the TTI analysis above, PTI performance ranges from “Fair” on more urban segments to “Good” in more outlying areas (**Figure 2**). The one exception is “Poor” reliability on Pima Mine Road west of I-10, likely related to truck traffic in and out of the ASARCO Mission Mine Complex. The specific cause of the issue is not known but could stem from some combination of issues, including periodic challenges for trucks merging on to I-19, a specific event, such as an accident, that occurred during the travel-time observation period, or an anomaly in the data.

Figure 2 Truck Planning Time Index on Regional Freight Corridors (2016)



Current and Future Roadway Congestion

The third and fourth factors considered were current (2017) and future (2045) congestion on RFC segments. For this analysis, congestion was measured using a volume-to-capacity (V/C) ratio for the highest modeled peak period (either a.m. peak or p.m. peak) on RFC segments under normal operating conditions (V/C does not account for congestion resulting from traffic accidents, construction, special events or others). Unlike TTI and PTI analyses, V/C measures segment congestion for all vehicles, not just trucks. An advantage of considering V/C is that, because it is modeled data, it can be used to estimate future congestion conditions.

VOC indicates how high volumes are on a given segment compared with the capacity of the roadway. A VOC of 1 indicates that segment volume is 100% of capacity, resulting in traffic gridlock. A VOC at or below 0.8 at peak hour is desirable. The congestion thresholds in **Table 4** and **Table 5** are consistent with those PAG used in the development of the 2045 Regional Mobility and Accessibility Plan (RMAP).

Table 4 Current congestion performance thresholds (2017)

Performance Consideration	Measure	V/C Ratio	Performance Rating	Performance Score
Current peak-hour congestion	2017 volume-to-capacity ratio (highest of either AM or PM peak)	<0.8	Good	3
		0.8–1	Fair	2
		>1	Poor	1

Based on PAG's Travel Demand Model outputs, most of the regional network is currently performing at acceptable levels in terms of meeting traffic demand (**Figure 3**).

Figure 3 Current peak hour congestion on Regional Freight Corridors (2017)

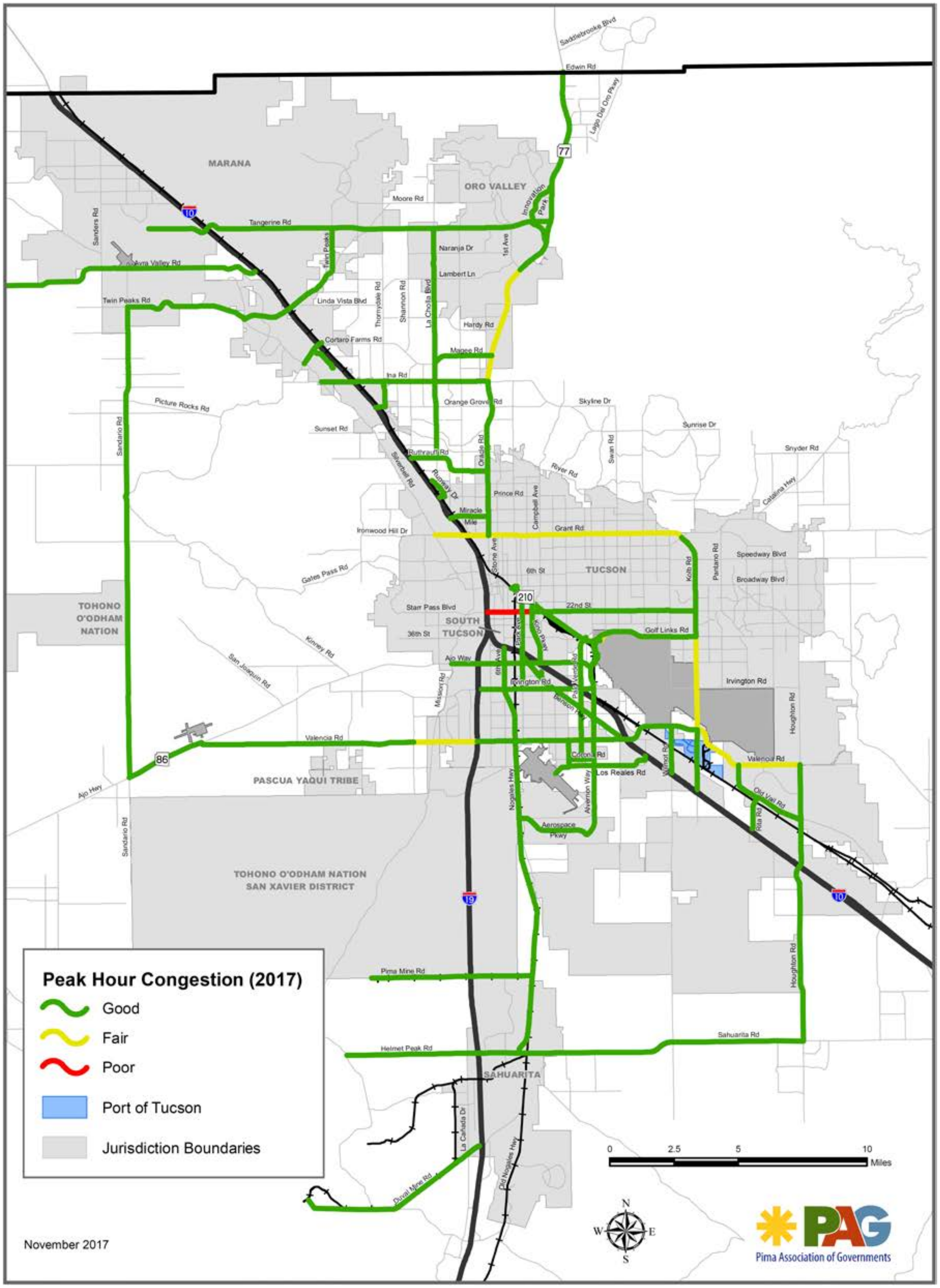


Table 5 Future congestion performance thresholds (2045)

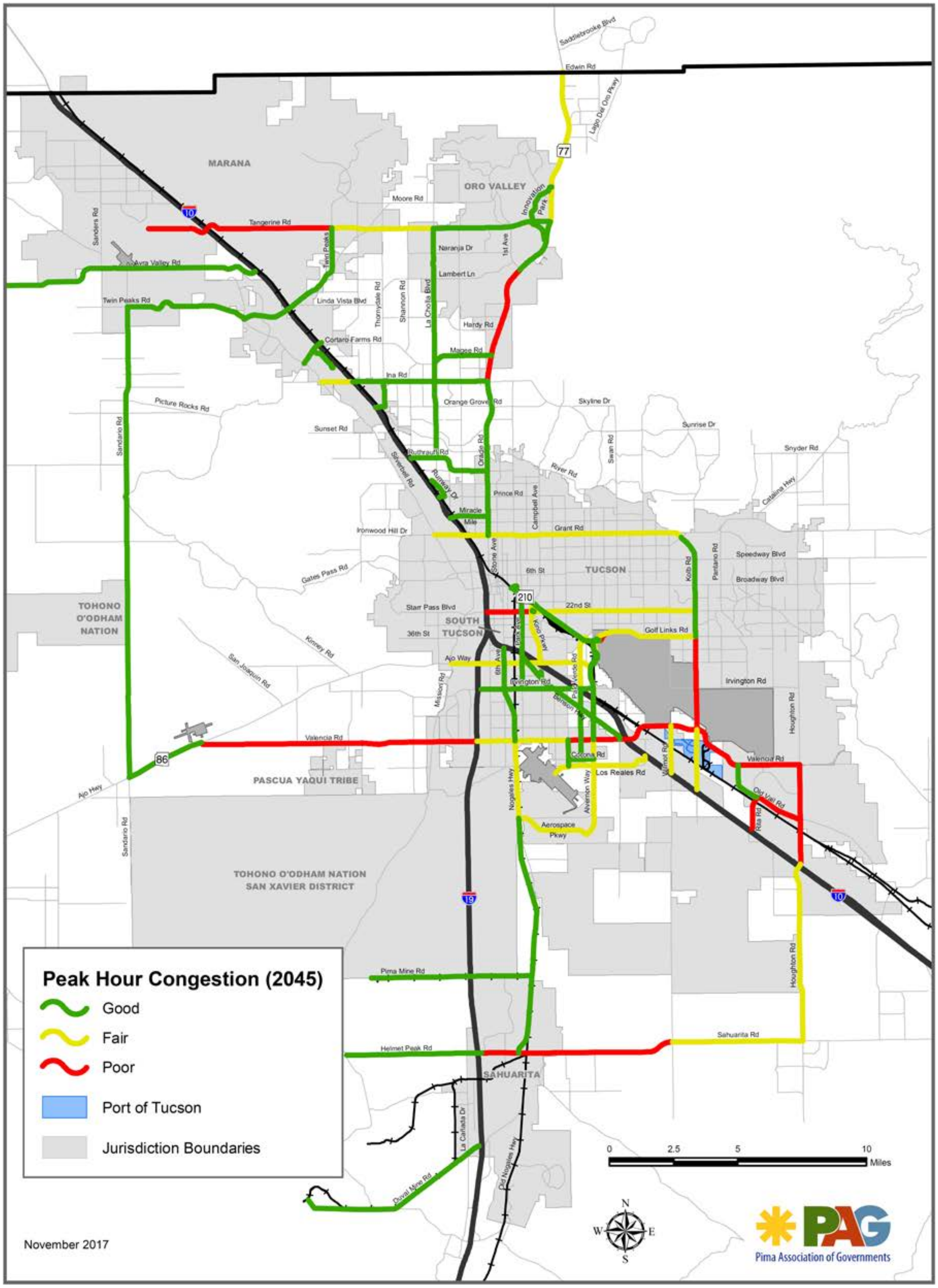
Performance Consideration	Measure	Value	Performance Rating	Performance Score
Future peak-hour congestion	2045 volume-to-capacity ratio (highest of either AM or PM peak)	<0.8	Good	3
		0.8–1	Fair	2
		>1	Poor	1

Future congestion levels were estimated using the traffic modeling PAG conducted for the 2045 RMAP. This analysis looks beyond just current performance issues to indicate where future capacity investments may be needed. Travel demand modeling for 2045 assumes that no new capacity would be added between the base year and 2045.

The congestion performance thresholds for 2045 are the same as 2017.

Based on current assumptions, if no capacity is added to the RFC network, the region can expect a significant reduction in corridor performance over the coming decades, which will affect both passenger vehicles and freight (**Figure 4**).

Figure 4 Future peak-hour congestion on Regional Freight Corridors (2045)



Bridge Condition

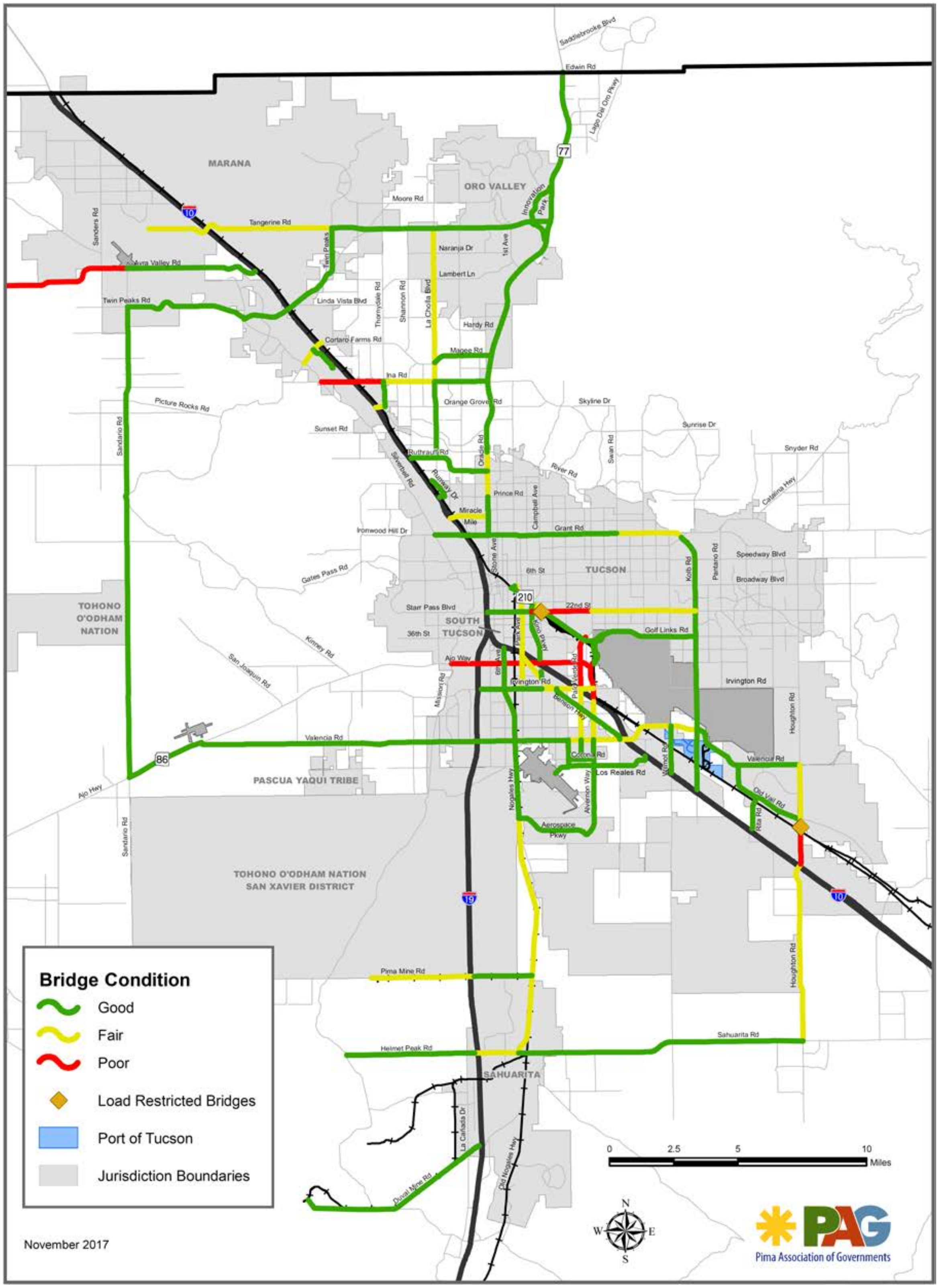
The final factor PAG used in evaluating RFC performance was bridge condition. Bridge condition data come from the National Bridge Inventory database, which provides condition information on bridge deck, superstructure and structure. Bridges are classified as either good, fair or poor based on a condition score given for each part of the bridge (poor condition for any part of the bridge results in a "Poor" classification for the entire bridge structure).

For PAG's RFC performance analysis, each segment was scored based on the lowest-rated bridge on the segment (**Table 6**). This approach assumes that a single bridge in poor condition, if not addressed, could potentially become the capacity limitation of a roadway for heavy vehicles, though it should be noted that a "Poor" bridge condition rating in no way indicates a bridge presents a safety hazard to the traveling public. When the condition deteriorates to such a degree that a bridge can no longer support heavy-weight vehicles, the bridge will be posted with a weight limit. There are currently two bridges with weight limits below 80,000 pounds on the RFC network shown in **Figure 5**.

Table 6 Bridge condition performance thresholds

Performance Consideration	Measure	Value	Performance Rating	Performance Score
Bridge Condition	Bridge Condition on the RFC network	All bridges rated good or no bridges present	Good	3
		At least 1 bridge in fair condition	Fair	2
		At least 1 bridge in poor condition	Poor	1

Figure 5 Bridge condition on Regional Freight Corridors



Composite Freight Performance Score

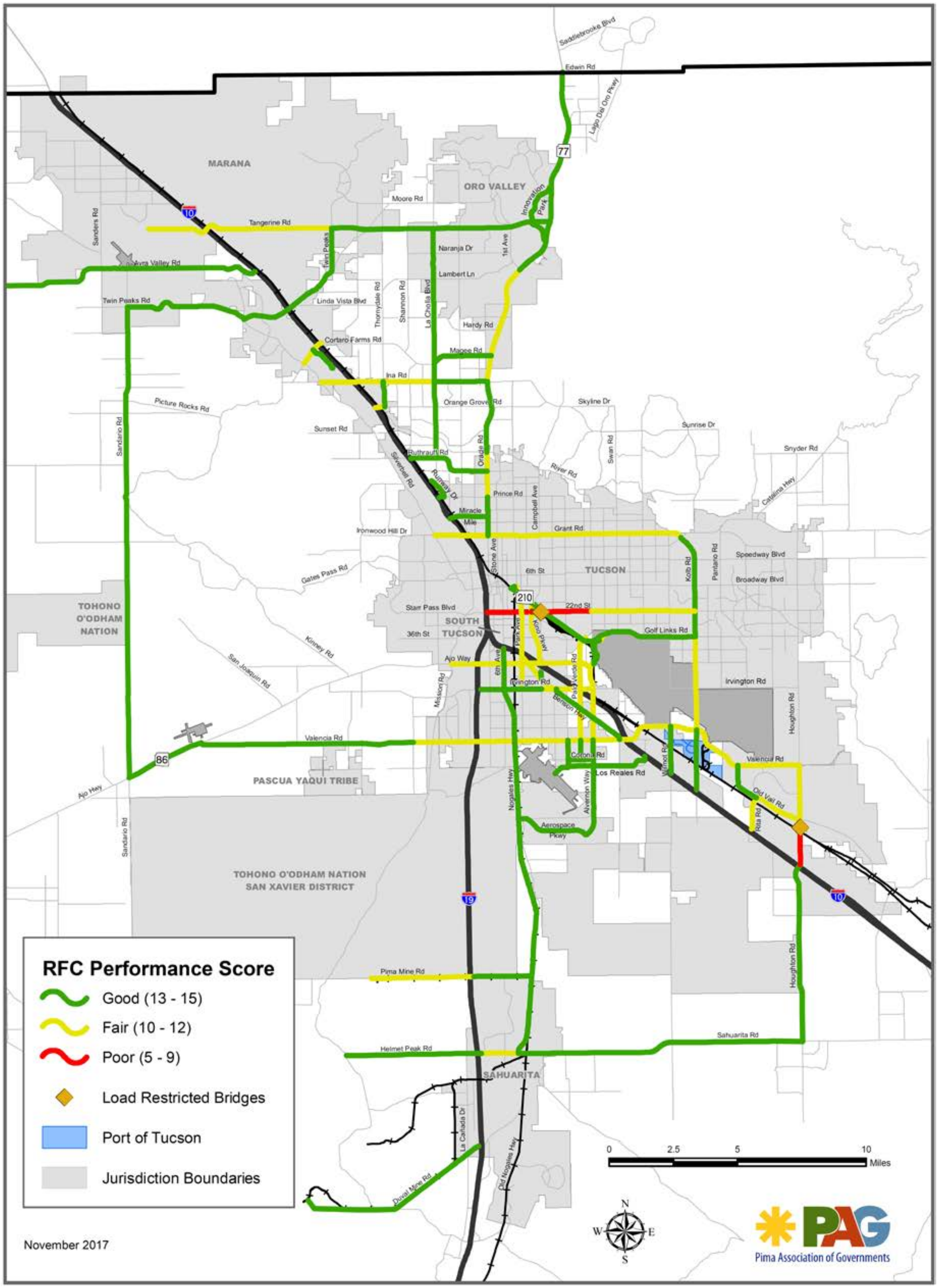
PAG created the Composite Freight Performance Score for the RFC network by combining the five factors just described. The composite performance score provides a broad assessment of how well the corridors serve freight needs. This high-level screening of the network is intended to illustrate where the system is underperforming from a freight perspective to assist with determining where further examination of causes may be warranted. Solutions will be location-specific and could range from traffic signal adjustments all the way up to corridor-scale capacity projects.

Table 7 shows how the factors discussed previously were used to develop a Composite Freight Performance Score. All factors were weighted equally. Segments with weight-restricted bridges were automatically listed as “Poor” as a result of not being able to support standard 80,000-pound trucks. The corridor score is presented in **Figure 6**.

Table 7 Composite Freight Performance Score thresholds for RFCs

Performance Consideration	Measure	Value	Performance Rating	Performance Score
Recurring peak-hour delay	Truck Travel Time Index	<1.3	Good	3
		1.3–2.0	Fair	2
		>2.0	Poor	1
Travel time reliability	Truck Planning Time Index	<3.0	Good	3
		3.0–6.0	Fair	2
		6.0	Poor	1
Current peak-hour congestion	2017 VOC (highest of either AM or PM peak)	<0.8	Good	3
		0.8–1	Fair	2
		>1	Poor	1
Future peak-hour congestion	2045 VOC (highest of either AM or PM peak)	<0.8	Good	3
		0.8–1	Fair	2
		>1	Poor	1
Bridge condition	Bridge Condition on the RFC network	All bridges rated good or no bridges present	Good	3
		At least 1 bridge in fair condition	Fair	2
		At least 1 bridge in poor condition	Poor	1
Freight corridor performance	Composite freight score	Good		>12
		Fair		10–12
		Poor		<10

Figure 6 Composite Freight Score for RFCs



Most of the RFC network is performing in the “Fair” to “Good” range with the exceptions being on South Houghton Road and on 22nd Street. Two of these segments—on 22nd Street at Aviation Parkway and on Houghton Road and Old Vail Road—are rated as “Poor” due to weight-restricted bridges.

Improvements are already planned on many segments of the RFC network, including on the “Poor” segments. **Table 8** shows segment locations of the RFC network and indicates whether projects are already planned or programmed for the location. A more detailed description on the projects can be found in Chapter 5 of the Freight Plan.

Table 8 Regional Freight Corridor planned projects

Street Name	From	To	Composite Freight Performance	Planned or Programmed Project?
22nd Street	I-10	Aviation Pkwy	Poor	**Y**
22nd Street	Aviation Pkwy	Alvernon Way	Poor	Y
22nd Street	Alvernon Way	Kolb Road	Fair	N
6th Avenue	Irvington Road	I-10	Good	N
Aerospace Parkway	Nogales Hwy	Alvernon Way	Good	Y
Ajo Hwy	Sandario Road	Valencia Road	Good	Y
Ajo Way	Mission Road	Alvernon Way	Fair	Y
Alvernon Way	Aerospace Parkway	Valencia Road	Good	Y
Alvernon Way	Valencia Road	I-10	Fair	Y
Alvernon Way	I-10	Aviation Parkway	Fair	Y
Aviation Parkway	Broadway Boulevard	22nd Street	Good	N
Aviation Parkway	22nd Street	Golf Links Road	Good	N
Avra Valley Road	West of Pump Station Road	Sandario Road	Good	N
Avra Valley Road	Sandario Road	I-10	Good	Y
Benson Hwy	Park Avenue	Irvington Road	Fair	N
Benson Hwy	Irvington Road	Valencia Road	Good	N
Business Park Drive	N Cortaro Road	Hartman Ln	Good	N
Campbell Avenue	I-10	Benson Hwy	Good	Y
Corona Road	Country Club Road	Alvernon Way	Good	N
Cortaro Road/ Cortaro Farms Road	Silverbell Road	Joplin Lane	Fair	Y
Country Club Road	Los Reales Road	Valencia Road	Good	N
Duval Mine Road	Freeport McMoran	I-19	Good	N

Street Name	From	To	Composite Freight Performance	Planned or Programmed Project?
Euclid Avenue/ Park Avenue	Broadway Boulevard	22nd Street	Fair	N
Golf Links Road	Alvernon Way	Craycroft Road	Good	N
Golf Links Road	Craycroft Road	Kolb Road	Good	N
Grant Road	Silverbell Road	Oracle Road	Fair	Y
Grant Road	Oracle Road	Swan Road	Fair	Y
Grant Road	Swan Road	Tanque Verde Road	Fair	N
Helmet Peak Road	Mission Road	I-10	Good	Y
Houghton Road	Sahuarita Road	I-10	Good	Y
Houghton Road	I-10	Valencia Road	Poor	Y
Ina Road	Silverbell Road	I-10	Fair	Y
Ina Road	I-10	Thornydale Road	Fair	Y
Ina Road	Thornydale Road	La Cholla	Fair	N
Ina Road	La Cholla	Oracle Road	Good	N
Innovation Market Drive	Tangerine Road	Oracle Road	Good	Y
Innovation Park Drive	Tangerine Road	Rancho Vistoso Boulevard	Good	Y
Irvington Road	I-19	Campbell Avenue	Good	Y
Irvington Road	Campbell Avenue	Alvernon Way	Fair	N
Kino Parkway	I-10	Aviation Parkway	Fair	N
Kolb Road	I-10	Valencia Road	Good	Y
Kolb Road	Valencia Road	Golf Links Road	Fair	Y
Kolb Road	Golf Links Road	Tanque Verde Road	Good	N
La Cholla Boulevard	Ruthrauff Road	Ina Road	Good	N
La Cholla Boulevard	Ina Road	Tangerine Road	Good	Y
Los Reales Road/Craycroft Road	Tucson Airport	I-10	Good	N
Magee Road	La Cholla Boulevard	Oracle Road	Good	N
Miracle Mile	I-10	Oracle Road	Good	Y
Nogales Hwy	Sahuarita Road	Aerospace Parkway	Good	N
Nogales Hwy	Aerospace Parkway	Valencia Road	Good	Y
Nogales Hwy	Valencia Road	Irvington Road	Good	N

Street Name	From	To	Composite Freight Performance	Planned or Programmed Project?
Old Vail Road	Valencia Road	Rita Road	Good	N
Old Vail Road	Rita Road	Houghton Road	Fair	N
Oracle Road	Grant Road	Prince Road	Good	N
Oracle Road	Prince Road	River Road	Fair	N
Oracle Road	River Road	Ina Road	Good	Y
Oracle Road	Ina Road	N 1st Avenue	Fair	Y
Oracle Road	N 1st Avenue	Tangerine Road	Good	N
Oracle Road	Tangerine Road	Pima County Line	Good	N
Orange Grove Road	I-10	Thornydale Road	Fair	N
Palo Verde Road	Corona Road	Valencia Road	Good	N
Palo Verde Road	Valencia Road	I-10	Fair	N
Palo Verde Road	I-10	Aviation Parkway	Fair	N
Park Avenue	22nd Street	Irvington Road	Fair	Y
Pima Mine Road	Mine	I-19	Fair	N
Pima Mine Road	I-19	Nogales Hwy	Good	N
Prince Road	I-10	Runway Drive	Good	N
Rita Road	I-10	Old Vail Road	Fair	N
Runway Drive	City of Tucson Jurisdictional Boundary	Prince Road	Good	N
Ruthrauff Road/Wetmore Road	I-10	Oracle Road	Good	Y
Sahuarita Road	I-19	S Nogales Highway	Fair	Y
Sahuarita Road	S Nogales Highway	S Wilmot Road	Good	Y
Sahuarita Road	S Wilmot Road	S Houghton Road	Good	Y
Sandario Road	Ajo Highway	Twin Peaks Road	Good	Y
Tangerine Road	Quarry	Twin Peaks Road	Fair	Y
Tangerine Road	Twin Peaks Road	La Cholla	Good	Y
Tangerine Road	La Cholla	Oracle Road	Good	Y
Thornydale Road	Orange Grove Road	Ina Road	Good	N
Twin Peaks Road	Sandario Road	Silverbell Road	Good	N
Twin Peaks Road	Silverbell Road	I-10	Good	N
Twin Peaks Road	I-10	Tangerine Road	Good	N
Valencia Road	Ajo Highway	S Cardinal Avenue	Good	Y

Street Name	From	To	Composite Freight Performance	Planned or Programmed Project?
Valencia Road	S Cardinal Avenue	I-10	Fair	Y
Valencia Road	I-19	Country Club Road	Fair	Y
Valencia Road	Country Club Road	I-10	Fair	Y
Valencia Road	I-10	Kolb Road	Fair	Y
Valencia Road	Kolb Road	Houghton Road	Fair	Y
Vistoso Commerce Loop	Rancho Vistoso Boulevard	Oracle Road	Good	N
Wilmot Road	I-10	Valencia Road	Good	N

Appendix 3

Literature Review

Appendix 3 contains the Pima Association of Governments (PAG) Regional Freight Plan (Freight Plan) Literature Review, which was conducted to identify the primary issues, needs and concerns of stakeholders in the PAG region as they relate to freight. This in-depth analysis will ensure the Freight Plan successfully incorporates freight-related elements from other plans and programs into the planning process in order to maintain consistency and avoid redundancies. Federal and state provisions also were analyzed, including the recently passed Fixing America's Surface Transportation (FAST) Act and the Arizona State Freight Plan.

This document summarizes PAG research from the review of various state, county, municipal and other policy documents relevant to the PAG region and this freight planning effort. In order to better understand the regional planning context and align with regional priorities, PAG reviewed each plan in its entirety while focusing on vision statements, associated goals and objectives, and any freight-related content. The following planning documents were reviewed (listed by category):

General and Comprehensive Plans

- City of Tucson General & Sustainability Plan – "Plan Tucson" (2013)
- Pima County Comprehensive Plan – "Pima Prospers" (2015)
- Town of Marana General Plan (2011)
- Town of Marana Strategic Plan (2015)
- Town of Oro Valley General Plan – "Your Voice, Our Future" (2016)
- Town of Sahuarita General Plan – "Aspire 2035" (2015)

Modal Plans and Studies

- Arizona Department of Transportation (ADOT) 2017-2021 Five-Year Transportation Facilities Construction Program (2016)
- ADOT Arizona Multimodal Freight Analysis Study (2008)
- ADOT Arizona-Sonora Border Master Plan (2012)
- ADOT Arizona State Rail Plan (2011)
- ADOT I-10 Corridor Profile Study (SR 202L to New Mexico State Line) (2016)
- ADOT I-10 Phoenix-Tucson Bypass Study (2008)

- ADOT P2P Link Methodologies and Implementation Plan (2014)
- ADOT State Freight Plan (2016)
- ADOT State Long-Range Transportation Plan ("What Moves You Arizona") (2011)
- Joint Planning and Advisory Council (JPAC) Freight Transportation Framework Study (2012)
- JPAC Import Distribution Facility: Tucson International Airport Focus Area (2012)
- JPAC Technical Memorandum I – Freight Shipper and Carrier Profile and Commodity Flow Profile (2012)
- PAG 2045 Regional Mobility and Accessibility Plan (2016)
- Transportation and Trade Corridor Alliance Roadmap (2013)
- Tucson International Airport Master Plan (2014)

Corridor Studies

- ADOT I-10 Corridor Profile Study (SR 202L to New Mexico State Line) (2016)
- ADOT Key Commerce Corridors (2014)
- ADOT I-11 and Intermountain West Corridor Study: Southern Arizona Future Connectivity Corridor Feasibility Assessment Report (2014)
- Pima County Sonoran Corridor Economic and Revenue Impact Analysis (2013)

Economic Development Plans and Reports

- Arizona Commerce Authority Business Plan (2012)
- Eller College Arizona-Mexico Economic Indicators 2015 Annual Report (2015)
- Pima County Economic Development Plan (2015)
- Sun Corridor Inc. Economic Blueprint (2014)

Key Findings

Throughout the review process, a number of freight-related themes were prevalent in nearly every document. The project team separated these thematic elements into three categories: economic development, system performance and regional resilience. These themes are consistent with the projects, goals and performance measures set forth in the PAG 2045 Regional Mobility and Accessibility Plan (RMAP), National Highway Freight Program, Arizona State Freight Plan and other freight planning programs. The following is a list of the key outcomes as they relate to these three themes.

1. Economic Development

- Improve connectivity to domestic and international markets.
- Improve and maintain an efficient freight network to increase economic competitiveness.
- Ensure goods can reach destinations in a cost-effective and timely manner.
- Increase dialogue with key freight partners, both domestic and international, on current and future projects.
- Coordinate development of freight infrastructure with strategic development investments.
- Establish the PAG region as a leader in high-value trade and investment by developing supply chain strategies and multidirectional and multimodal logistic hubs and by strengthening relationships with key trade partners.

2. System Performance

- Develop local mobility initiatives to ensure efficient movement of freight on local network.
- Support current and future infrastructure capacity building projects, such as the Sonoran Corridor and expansion of the Port of Tucson.
- Utilize state-of-the-art technologies to improve system performance and monitoring.
- Coordinate development of freight infrastructure to accommodate growth in business development.
- Identify and mitigate areas of congestion along problematic roadway segments.
- Improve surface transportation accessibility to warehousing and distribution centers associated with logistics centers.
- Align future roadway projects with forecasted increase in truck traffic volume.

3. Regional Resilience

- Support existing regional primary job centers.

- Develop and promote existing regional assets to both domestic and international markets such as East Asia, Mexico and Canada.
- Maintain existing freight system infrastructure.

General and Comprehensive Plans

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Plan Tucson, City of Tucson General & Sustainability Plan	2013	City of Tucson	Plan Tucson is the City's most recent General & Sustainability Plan, which was ratified by voters and approved by Mayor and Council in 2013. The plan was prepared by City of Tucson staff and emphasized outreach to the general public, other City departments, governmental agencies, non-governmental organizations, business groups, and neighborhoods. The plan replaced the 2001 Tucson General Plan, per Arizona State Law, which requires that each jurisdiction readopt or develop a new plan every 10 years. The plan provides long-term public policy to guide more specific planning, program, and project decisions affecting key elements that shape Tucson and allow it to function successfully.	▪ Introduces policy goals to ensure the success of commercial areas through targeted investment, incentives, and other revitalization strategies. ▪ Environmentally sensitive design, including air and noise quality, will be enforced near industrial and airport zones and along roadways ▪ Areas with long-term economic development potential are given priority ▪ Seeks to integrate land use, transportation, and urban design policies ▪ Participation encouraged in the development of a coordinated regional, multi-modal transportation system that improves the efficiency, safety, and reliability of transporting people and goods both inter- and intra-regionally. ▪ Coordinates comprehensive revision of the Airport Environs Plan, including areas beyond the current Airport Environs Overlay Zone, taking into account noise and resident-related concerns. ▪ Supports the expansion of freight multi-modal transportation services to better connect Tucson to other markets and destinations.
Pima Prospers, Pima County Comprehensive Plan	2015	The Planning Center for Pima County	Pima Prospers is the comprehensive plan policy document for Pima County. The plan establishes government policy to guide public and private activities as they relate to growth, land use, economic development, community services, public facilities, infrastructure and utilities, resource utilization and energy conservation. Furthermore, it informs the distribution of county budget dollars to a multitude of programs and agencies. The plan organizes and integrates County services under four major strategic areas: use of land, physical infrastructure connectivity, human infrastructure connectivity, and economic development. The plan is action-oriented and seeks to align its annual budget, capital improvement program, and future bonding programs efficiently and in a fiscally responsible manner.	▪ Long-term viability of the region's infrastructure is a major focus area. ▪ Proposes focusing development investments in economic development generating areas such as aerospace, defense, and logistics industries. ▪ Collaboration is vital with key transportation and logistics partners, such as TIA and the Port of Tucson. ▪ The region must protect and retain its existing major employers, such as Raytheon and Davis-Monthan AFB, including their current/potential infrastructure needs as well as the needs of their supply chain partners. ▪ Focuses on creating new opportunities for job growth by maximizing international trade with Mexico, Canada, and Asia. ▪ Seeks to position the Port of Tucson as a key transportation and logistics center by identifying and developing rail infrastructure expansion opportunities. ▪ Actively seeks financial resources to repair and rebuild roads to aid the logistics industry and improve the overall condition of the region's streets.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Marana 2010 General Plan	2011	Town of Marana	The Town of Marana General Plan is a policy document providing direction for future growth and development of the community. The plan is comprehensive in nature and seeks to weave land use, transportation, environmental concerns, economic development, housing, parks and recreation, and public facilities and services into a coordinated and comprehensive growth and development strategy. The General Plan was most recently updated in 2007.	▪ The Town sees great growth potential in its aviation, rail, and trucking services. ▪ Freight transfers by rail and truck are encouraged by maintaining interchange and railroad siding access at appropriate locations. ▪ Seeks to maximize economic opportunities using the community's major transportation infrastructure (I-10, rail, airports) to attract businesses and jobs. ▪ Aims to provide maximum economic opportunities to attract business suppliers to support regional industries. ▪ Focuses on developing transportation logistics type projects, including a transportation logistics marketing plan and identifying parcels for such projects.
The Marana Strategic Plan	2015	Town of Marana	According to the document, "The Marana Strategic Plan sets a course for action to be taken by elected leaders and professional staff to address community needs and position Marana for the future." The overriding principles of the Plan are: financial sustainability, quality public service, strategic partnerships, and local resource investment.	▪ The Marana Airport is once again a primary focus, specifically increasing visibility for business development opportunities. ▪ Proposes infrastructure studies for crucial corridors and activity centers around the airport and I-10. ▪ Promotes cultivation and participation in state and national partnerships, such as Sun Corridor, Inc., and the Site Selector's Guild to promote the Town. ▪ Seeks to leverage key staff and elected officials to develop strategic partnerships through various legislative efforts in order to attract, retain, and expand commerce and industry.
Aspire 2035 (Sahuarita General Plan)	2015	Town of Sahuarita	Aspire 35 is Sahuarita's overarching policy document and primary tool for guiding the future of the Town. Since incorporation in 1994, the Town has grown significantly, resulting in the need and desire to update the 2003 General Plan. In doing so, the Town is positioning itself to include goals and policies better suited to a rapidly growing community. The newly updated Plan sets policy addressing the seven topic areas required by State law. In addition, elements required for larger cities have been included due to its growth potential, including recreation, public services and facilities, energy, housing, safety, and conservation, rehabilitation and redevelopment.	▪ Noise mitigation is a primary concern given the Town's residential nature. ▪ Aims to provide a comprehensive transportation network with multiple routes and modes to all land uses, services, and destinations. ▪ Continues to support and build upon the Town's existing economic pillars: mining, tourism, entrepreneurship, home building, and small business, as well as complimentary sectors within the region such as aerospace and defense and information and communications technology. ▪ Promotes coordination with the County and State to support major transportation improvement projects. ▪ A primary goal of the Sahuarita East Conceptual Area Plan (SECAP) area is to plan for near- and mid-term commercial and business development along Sahuarita Road, the Sonoran Corridor, Wilmot Road, Houghton Road and Nogales Highway. ▪ Where warranted, future roadway improvement projects may include grade separation as part of the design based on safety experience, traffic volumes and other factors.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Your Voice Our Future, Town of Sahuarita General Plan	2016	Town of Oro Valley	Your Voice, Our Future is the general plan for Oro Valley. It expresses the community's development goals and embodies public policy relative to the distribution of future land uses, both public and private. The policies and programs of the l plan are intended to underlie most land use decisions. Arizona state law requires all cities, towns and counties in Arizona to have an updated General Plan every 10 years that is approved by voters, and this will replace the 2005 General Plan if it's approved by voters in November 2016.	▪ Commercial areas are identified as Tier I Growth Areas along the Oracle Road corridor, from Orange Grove Rd. to the north end of Innovation Park.

Modal Plans and Studies

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Tentative ADOT 2017-2021 Five-Year Transportation Facilities Construction Program	2016	ADOT	The Five-Year Transportation Facilities Construction Program details how the Arizona Department of Transportation intends to invest in future transportation projects. The program is updated each year for the subsequent five-year period. The State Transportation Board reviews and approves the program in accordance with Arizona Revised Statutes §28-304.The program is divided into three sections: Highways, Regional Transportation Plans, and Airport Improvements.	The following are construction projects that may influence freight planning in the PAG region: ▪ I-10, Ina Rd TI: $68.1M in 2017 ▪ I-10, Kolb Rd, Signal TI: $0.5M in 2017 ▪ I-10, Houghton Rd, Signal TI: $0.4M in 2017 ▪ I-10, Rita Rd, Signal TI: $0.5M in 2017 ▪ I-10, Vail Rd, Signal TI: $0.5M in 2017 ▪ I-10, Wilmot Rd, Signal TI: $0.5M in 2017 ▪ I-10, SR-210 Design/ROW: $2.3M in 2017 ▪ I-10 Ruthrauff Rd TI: $86.5M in 2018 ▪ I-10, Houghton Rd, TI: $30M in 2019 ▪ I-10, King Parkway TI Phase 1: $40.8M in 2021 ▪ I-19, Ajo Way TI: $21.5M in 2018 ▪ SR77, River Rd-Suffolk Dr: $12.4M in 2019 ▪ SR-410 Tier 1 Alignment Study: $3.5M in 2017
ADOT Arizona Multimodal Freight Analysis Study	2008	ADOT	ADOT completed the Multimodal Freight Analysis Study in 2008. This study addressed all modes of freight transportation in Arizona – trucking, rail and aviation – to provide a detailed assessment of critical freight issues and emerging trends, as well as their relationship to transportation policy and infrastructure. From this information, infrastructure needs and deficiencies were identified, as was a recommended strategy for including freight analysis as part of Arizona's long-range planning process. This study included the following: ▪ Broad themes to guide future freight planning; ▪ A description of how multimodal transportation networks impact the freight industry; ▪ Potential impacts of freight strategies on economic development; ▪ Strategy for freight data collection, analysis, and planning; and ▪ Measurable indicators describing the impact of freight traffic on the performance of Arizona's multimodal freight transportation network.	▪ The Study promotes linking freight planning to economic development by engaging the private sector, supporting freight-related education and training, and marketing the link between transportation and Arizona's economy. ▪ Coordinating freight planning and local land use planning with both the public and private sectors is encouraged in order to support and develop land use planning guidelines for freight-intensive development. ▪ Preserving and prioritizing key freight infrastructure is recommended. ▪ Opportunities to improve freight operations are recommended, such as the use of innovative technologies, expansion of the existing intermodal connector network, and incorporation of heavy truck movements into highway design. ▪ Proposes the enhancement of freight system safety and security through target improvements, improved parking opportunities, railroad crossing improvements, performance-based enforcement policies, and monitoring of TSA air cargo screening. ▪ Promotes "green" freight initiatives and the study of freight movement through congested urban corridors.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
ADOT Arizona-Sonora Border Master Plan	2013	ADOT	This Border Master Plan presents a comprehensive binational approach to coordinating the planning and delivery of projects to improve traffic operations at each of nine land ports of entry (LPOEs) along the Arizona-Sonora border and to enhance the efficiency of the multimodal transportation infrastructure providing access to the LPOEs.	▪ Identifies, prioritizes, and promotes LPOE and related transportation projects and services, resulting in 160 projects in Arizona and Sonora. ▪ Designs a process to ensure relevant international stakeholders participated in the planning of LPOE projects and related transportation infrastructure improvements in the border region. ▪ Seeks to increase understanding of the LPOE and transportation planning processes on both sides of the border. ▪ Establishes a process for continued dialogue among relevant international stakeholders on current and future projects, especially through coordination of planning and programming processes adopted and pursued by study participants/partners. ▪ Promotes the advancement of the CANAMEX corridor to enhance overall freight movement to the north and south through Arizona and resulting potential economic development opportunities for freight handling and processing.
ADOT Arizona State Rail Plan	2011	ADOT	The Arizona State Rail Plan (SRP) is the first comprehensive assessment of Arizona's rail needs and comes in response to the State's rapidly growing population and expanding business sector. The SRP presents a series of issues and opportunities relative to the future of rail development in Arizona, including a series of implementation directions and a discussion on funding options. The SRP seeks to have rail projects included in the State's long-range planning processes to improve regional and statewide safety mobility. The principle purpose is to convey the magnitude of the rail needs in the State and set forth a policy framework through which strategic actions can be taken to realize the full potential of passenger and freight rail transportation.	This Plan recommends certain actions in four separate "Corridors of Opportunities," three of which are directly or indirectly associated with transportation to/from Arizona's international border with Sonora. ▪ The **"**Arizona Spine**"** is defined as a north-south corridor through the central part of Arizona. Actions in this corridor focus on passenger rail opportunities to support the emerging Sun Corridor and the tourism industry. In addition to the passenger rail focus, this strategy includes expanding existing rail freight through capacity, classification yards, intermodal facilities, and other freight logistic centers. ▪ The "CANAMEX Corridor" The CANAMEX Corridor definition incorporates the concept of a Western Passage of the CANAMEX trade route with a focus on improving connections between western Arizona and Mexico. This route reflects a vision for supporting the priorities of the CANAMEX Coalition while also establishing a Southwestern High Speed Rail Network. The goal of actions in this corridor is to improve mobility, promote sustainability, and preserve environmental resources. ▪ The **"**Sunset Route**"** has an east-west orientation generally following the cross-country transportation corridor formed by UPRR Sunset Route and Interstates 8 and 10. Actions in this corridor focus on enhancements of the transportation network designed to move people and goods within Southern Arizona and across the country more efficiently.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
ADOT State Long-Range Transportation Plan (“WhatMovesYouArizona”)	2011	ADOT	The Long-Range Transportation Plan (LRP) provides strategic direction to guide future multimodal transportation system investments over a 25-year period. It is important to note that the LRP does not examine or recommend specific projects. The plan takes a performance-based approach by documenting existing conditions and future trends that could influence system performance and investment needs; defining State transportation system goals, objectives, and performance measures that reflect input from stakeholders and partner agencies; assessing future needs and anticipated revenues; considering programmatic investment choices to illustrate likely future system performance under different investment mixes; and establishing a preferred investment option that is based on a realistic revenue forecast (fiscally-constrained). The plan builds on the comprehensive 2050 land use and multimodal transportation vision developed through the *Building a Quality Arizona* (*bqAZ)* long-range planning effort. *Building a Quality Arizona* is a statewide planning effort to integrate transportation, land use, community, and economic development planning and identify long-term needs and potential funding sources.	▪ The assessment of freight and passenger rail draws from recently completed studies, including the 2009 Multimodal Freight Analysis, bqAZ and the framework studies, including the Statewide Rail Framework Study (2010). ▪ Performance measures for the LRP were built from existing ADOT measures and through collaboration and coordination with a number of committees. ▪ Targets were not established for the objectives or performance measures in the LRP; rather, the plan explains that performance trends will be helpful in gauging the effectiveness of investments. ▪ The Highway Economic Requirements System - State Version (HERS-ST) model, developed by FHWA, was used to determine 25-year State Highway System needs. HERS-ST is a performance-based highway investment model that considers engineering principles, system deficiencies, and economic criteria to determine required statewide improvements. ▪ A roadway condition database known as the Highway Performance Monitoring System (HPMS) provided the input information for this analysis. ADOT updates Arizona’s component of the HPMS annually and provides it to FHWA. ▪ Bridge needs were analyzed with the National Bridge Investment Analysis System (NBIAS) model. NBIAS is an analysis tool developed by the FHWA that estimates bridge maintenance, improvement, and replacement needs. Much like HERS-ST, the NBIAS model forecasts bridge performance and identifies improvements based on economic indicators.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Transportation and Trade Corridor Alliance Roadmap	2013	TTCA	The TTCA Roadmap is a comprehensive document designed to support moving Arizona toward a more globally competitive second century by focusing on high-value trade and investment, market connectivity, and alignment of policy and actions. The Roadmap was constructed by a group of experts from the public and private sectors, brought together by Governor Jan Brewer to develop a plan to position Arizona in a fast-growing global marketplace. The TTCA Roadmap supports a plan to invest $20 billion over 20 years to improve Arizona's existing transportation infrastructure while adding new infrastructure, focusing on key commerce corridors. TTCA leaders maintain it's this investment in infrastructure that will create the opportunity for robust connectivity. Leaders recognize that investment and connectivity is critical in order to reach a major goal set out in the Roadmap — double Arizona's trade with Mexico and other global markets by 2025 while solidifying Arizona's accessibility and global competitiveness.	▪ The roadmap seeks to establish Arizona as a leader in high-value trade and investment by developing supply chain strategies, developing multidirectional and multimodal logistic hubs, and strengthening relationships with key trade partners with a focus on Mexico. ▪ Improve connectivity to markets by developing an integrated transportation system supportive of the State's economic goals by supporting key commerce corridors, improving modal linkages, identifying and pursuing new funding, and ensuring system safety and reliability. ▪ Ensure alignment of Arizona's vision for transportation and trade among stakeholders and decision makers by strengthening the Arizona brand, obtaining and enhancing the latest data, and advocating for trade and transportation to elected officials, stakeholders, and the media.
ADOT I-10 Phoenix-Tucson Bypass Study	2008	URS for ADOT	The idea for a bypass corridor was originated by the ASTB to mitigate the massive increase in present and future traffic volumes in Phoenix and Tucson before the Great Recession. The need for the bypass corridor was examined by comparing the number of existing lanes on I-10 to the existing traffic volumes. Plans for future widening of I-10 and other related routes were also identified. The ability to widen I-10 through Tucson is very limited and provided a major reason for considering a bypass. The study looked at a West Segment (Buckeye to Casa Grande) and an East Segment (Casa Grande to Willcox). One alternative was chosen for the West Segment, and a number of alternatives were selected for the East Segment. The study concluded that there is a need for an I-10 bypass; however, the study noted substantial opposition to the concept, in particular alternatives passing through the San Pedro Valley or Aravaipa Valley.	▪ In 2005, traffic on I-10 in Tucson exceeded 150,000 vpd. Forecasts by PAG at the time indicated that traffic demand on I-10 in 2030 could exceed 300,000 vpd. ▪ Even with up to eight lanes in some areas (the estimated capacity of an eight-lane freeway is 196,000 vpd), the right-of-way in Tucson is very confined in some areas, which pointed toward the need for future congestion relief. ▪ The study forecasted that even with the improvements to the rail system, substantial increases in truck traffic appeared likely. At the time, the percentage of the total number of vehicles on I-10 that were heavy trucks (outside the two major metropolitan areas) was already 30 to 50 percent and could go higher. The study also forecasted exponential l urban growth in central Pinal County, thereby making I-10 an urban freeway from west of SR 85 to east of Tucson. This would have meant that interstate traffic on I-10 (including many trucks) would have been subjected to the typical urban peak-hour congestion for 150 miles.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
ADOT P2P Link Methodologies and Implementation Plan	2014	ADOT	“Linking the Long-Range Plan and Capital Improvement Program (P2P Link) development started with ADOT's multimodal visioning called "Building a Quality Arizona" (bqAZ), the 2010 Statewide Transportation Planning Framework Study that created a fiscally-unconstrained vision for the State's transportation system in 2050. bqAZ led to "What Moves You Arizona?," the State's Long-Range Transportation Plan 2010-2035, which applied financial constraint to the vision, identified anticipated revenues, and provided a recommended investment choice (RIC) that indicated how revenues would be allocated to four different investment types: preservation, expansion, modernization, and non-highway. The third step was the development of P2P Link, a performance-based approach to planning, programming, and financial decision making that ensures available funds are used in the most productive way to meet overall transportation system performance objectives. P2P Link connects the goals of the State LRTP to the ADOT Five-Year Construction Program. This connection ensures that the LRTP policy guidance is adhered to in improving the quality of the State transportation system.	▪ The principal basis of P2P Link is to establish a well-documented, understandable, logical, and defensible means of selecting and prioritizing projects in the capital improvement program that will allow the Arizona State Transportation System to meet the objectives identified in the Long Range Transportation Plan (LRTP). ▪ P2P Link was developed so that the ADOT freight plan would provide metrics and identification of strategic investment requirements to support measuring freight performance. The freight plan will provide the performance-driven link for identifying freight-specific project improvements. ▪
JPAC Freight Transportation Framework Study	2012	JPAC	Maricopa Association of Governments, in conjunction with the Joint Planning Advisory Committee (MAG, PAG and CAAG), has accepted the challenge to develop strategies to diversify the economic base of the Sun Corridor. The goal of the 18-month Freight Transportation Framework Study is to unite cities, counties, transportation authorities, freight entities, and businesses to protect, maximize, and expand commerce and economic vitality. The project study team will identify and develop freight related economic development opportunities and increase mobility and access for freight movements throughout the Sun Corridor.	▪ Lists four typologies relevant to freight facilities in the Sun Corridor: import center, manufacturing and local distribution center, mixing center, and forward distribution center. ▪ Selected Tucson International Airport as a focus area ideal to serve the roll as an import distribution facility due to the zone’s overall rating, industrial and commercial market potential, freight typology characteristics, as well its major transportation and location assets. ▪ Recommends developing a Sun Corridor Freight Development Zone with incentives, such as property tax reductions, state income tax credits, etc., for business seeking to locate within the region. ▪ Recommends development of the Aerospace Parkway and connectivity to rail and other modes (Port of Tucson).

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
JPAC Freight Transportation Framework Study – Technical Memorandum I – Freight Shipper and Carrier Profile and Commodity Flow Profile	2012	Parsons Brinckerhoff for JPAC	The study used information from shippers, carriers and an updated commodity flow data analysis to provide JPAC an analysis of why shippers make the goods movement decisions they do to enhance their supply chain effectiveness, while emphasizing how, where and why cargo moves. The study identified the physical freight inventories and operational freight profile of regional freight activity (Task 3), analysis of commodity flows and economic needs analysis (Task 4), an assessment of inland port market opportunities (Task 5) and the development of a freight transportation infrastructure alternatives analysis (Task 6) all with the purpose of fulfilling three study objectives: 1) Identify the freight data sources most useful for regional planning; 2) Develop an actionable plan of implementing the data that will leverage the region's freight asset base as a platform for economic growth; and 3) Identify opportunities to educate the public on the benefit of goods movement into, out of and through the Sun Corridor.	▪ Utilized a web based survey and follow-up interviews with the shippers, logistic service providers and carriers. Results were then compared with a larger database of shippers by culling pertinent information from the Supply Chain Consortium's database. ▪ The shipper surveys and interviews are particularly helpful in that they reached a broad audience with national, regional, and state perspectives. ▪ The Study provides an overview of commodity flows into, out of and through the Sun Corridor using 2011 FAF data. ▪ The entire study should be reviewed as a methodological reference since the majority of data is likely outdated.

Corridor Studies

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
ADOT Key Commerce Corridors	2014	ADOT	The Multimodal Planning Division (MPD) of ADOT identified the state's corridors where improvements to the transportation infrastructure support the greatest potential commercial and economic benefits. The "Key Commerce Corridors" represent a strategic statewide approach to leverage infrastructure improvements to enhance the state's economic position.	▪ The infrastructure improvements are categorized as Arizona Corridors ($18.8 B), Arizona Borders ($0.8 B), and Arizona Bridges ($0.4 B). ▪ The two corridors with relevance to the PAG region are the I-19 to Tucson Corridor ($2.4 B in improvements proposed) and the I-10 to New Mexico Corridor ($6.4 B in improvements proposed). ▪ The majority of recommended improvements for the I-19 to Tucson Corridor are focused in the border area, save widening I-19 from the border to Ajo Way. ▪ The I-10/I-8 Tucson to Phoenix Corridor recommends reconstruction of several major interchanges in the Tucson area as well as the widening of I-10 from Tucson to I-8. Multiple bridge improvements are recommended.
I-10 Corridor Profile Study (SR 202L to New Mexico State Line)	2016	ADOT	According to ADOT, the study will utilize performance-based measures relative to the I-10 corridor and use those measures as a means to prioritize future improvements in areas showing critical needs. The studies under this program are intended to assess the performance of Arizona's strategic highways and are candidates for consideration in ADOT's P2P project prioritization process.	▪ The study evaluates five performance areas using ADOT's P2P Link process: pavement, bridge, mobility, safety, and freight. ▪ The freight performance area consists of a single Freight Index and five secondary measures: non-recurring delay, recurring delay, road closures, bridge vertical clearance, and bridge vertical clearance restriction hot spots. ▪ The Freight Index, TTI, and PTI were calculated based on HERE data for 2014. Based on the results of the analysis, there are multiple problematic segments in/around Tucson, including segments 5, 7, 8, 9, 11, and 12.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
ADOT I-11 and Intermountain West Corridor Study: Southern Arizona Future Connectivity Corridor Feasibility Assessment Report	2014	CH2MHill and AECOM for ADOT and NDOT	ADOT, NDOT, FHWA, the Federal Railroad Administration (FRA), and in partnership with MAG and the Regional Transportation Commission of Southern Nevada (RTC), referred to as Core Agency Partners, are conducting the Interstate 11 (I-11) and Intermountain West Corridor Study. The Southern Arizona Future Connectivity Corridor includes the entire southern Arizona border with Mexico. The focus of this study portion spans from the international border to just north of the intersection of I-8 and I-10 near Casa Grande. The breadth of the future connectivity study segment allows higher-level visioning for this potential extension south of the Phoenix Metropolitan Area, with the ultimate goal to determine the best location(s) for a connection to Mexico, via an existing land port of entry (LPOE).	▪ Key factors that support the I-11 and Intermountain West Corridor's Goals and Objectives include the following: ➢ Legislation – Is there a federal, state, or local governmental mandate for the action? ➢ System Linkage – Is the proposed project a "connecting link?" How does it fit in the transportation system? ➢ Trade Corridor – Will the proposed facility enhance the efficient movement of freight in the study corridor? ➢ Modal Interrelationships – Will the proposed facility interface with and serve to complement airports, rail and port facilities, mass transit services, etc.? ➢ Capacity – Is the capacity of the present facility inadequate for the present traffic? Projected traffic? What capacity is needed? What is the level(s) of service for existing and proposed facilities? ➢ Economics – Projected economic development/land use changes indicating the need to improve or add to the highway capacity ➢ Project Status—Project history, including actions taken to date, other agencies and governmental units involved, action spending, schedules, etc. ▪ I-10 at I-19 is cited as one of three locations in FHWA's annual report on congestion at freight-significant highway locations. ▪ Tucson and Yuma were considered major freight hubs with the ability to connect to Mexican markets. ▪ Alternative "C" is deemed most favorable—it connects major freight and economic activity centers within Arizona and MX throughout entire corridor. Potential conflict with Tucson Mitigation Corridor and/or Pima County Biological Core Management Areas (Avra Valley).

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Pima County Sonoran Corridor Economic and Revenue Impact Analysis	2015	Applied Economics for Pima County	The study was commissioned by the County as part of the conceptual planning for the Sonoran Corridor and documents the projected economic and revenue impacts that could occur with full development of the Corridor. The Sonoran Corridor has been planned as a major multimodal logistics hub for national and international trade and a hub for job creation in aerospace, defense, and technology manufacturing. According to the study, the Sonoran Corridor is perhaps the "single largest economic development initiative undertaken in the last 50 years within Pima County." The study presents projections of the potential impacts in terms of jobs, wages, output, and tax revenues. These projections were based on profiles of 26 companies that may locate to the area and are split into three groups: light industrial, heavy industrial, and general.	▪ There is no reference to freight movement or freight infrastructure in the study. ▪ The Corridor could have an annual economic impact of $32.2 B. ▪ Tenant companies could directly employ over 104,000 people with an est. payroll of $5.2 B annually. ▪ Capital investment could result in an estimated $21.8 B in construction expenditures and 307,000 jobs in construction. Consumer spending and tenant companies could generate a significant amount of new local taxes.

Economic Development Plans and Reports

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Sun Corridor Inc. Economic Blueprint	2014	TREO (sponsored by TEP)	In 2007 TREO gathered Southern Arizona's leadership to develop a comprehensive plan to impact the long-term regional economy. The end result was the Economic Blueprint, designed to guide our community's economic development efforts and influence many of the factors that drive our competitiveness for years to come. The 2014 Update focuses on four areas: Talent, Infrastructure, Business Environment and Healthcare.	▪ The plan promotes seamless connectivity to Mexico and other Southwestern business markets. ▪ The plan supports TIA and rail asset capacity growth planning and local mobility initiatives, including the Aerospace Corridor, Sonoran Corridor, and TIA "synergies." ▪ Recommends locating a rail classification yard in Tucson in order to expand logistics and intermodal capabilities in the region. ▪ The plan supports raising freight weight limits in order to compete with neighboring states and to promote the POT as a major import/export distribution center. ▪ TREO (SCI) employs a series of strategies focused on the creation of export-based (primary) jobs—jobs which produce goods and services in excess of what can be consumed by the local market. ▪ The Blueprint focuses on four areas that contribute to stronger product delivery ("product" being the Tucson region itself): Talent, Infrastructure, Business Environment, and Healthcare. Focuses on supporting and maintaining the region's defense assets through the Mission Strong program.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Eller College Arizona-Mexico Economic Indicators 2015 Annual Report	2015	Eller College, University of Arizona	The Annual Report is prepared as a detailed profile of Arizona's trade and competitiveness in the U.S.-Mexico region relative to other border states on an annual basis. The AZMEX indicators were designed to monitor Arizona's trade and competitiveness in the U.S.-Mexico region across a range of key economic categories, such as Arizona's trade, border crossings, commodity flows through border ports of entry, and economic trends in Mexico. The project's overarching theme is that presentation of the most up-to-date factual knowledge on the region will enhance understanding and appreciation of the importance of Arizona's economic relationships with Mexico. The Report is organized into the following sections: Population, Economic Output, Exports to Mexico, Exports to Canada, Border Crossings, Commodity Flows, Foundations of Export-Based Economy, Foundations of Knowledge-Based Economy, Educational Attainment, and Foreign Direct Investment.	▪ Truck crossings represent an important segment of commercial border crossing activity along the U.S. – Mexico border. Trucks carry the largest value and volume of merchandise across the border, and are the primary means of transportation for Mexican fresh produce. In 2014, the Arizona BPOE share of southern truck crossings decreased 0.3%. ▪ Nogales is Arizona's largest border port of entry. This port has experienced steady, yet slow growth in truck crossings since 2004. ▪ Arizona train crossings declined 17.6% in 2014. Arizona's share of train crossings at southern border ports also decreased from 9.3% in 2013, to 7.6% in 2014. The report has a large amount of information on commodity flows to/from MX and the US. The majority of information is focused on the BPOEs.
Arizona Commerce Authority Business Plan	2012	Arizona Commerce Authority	The plan was created using a data-driven, quantitative process, supplemented by research, input from subject matter experts and working sessions with the ACA staff, advisors and stakeholders. The plan delineates the ACA's goals and strategies, guides key activities including specifically identified supporting tasks, and demonstrates how the ACA is organized to achieve its mission.	▪ The plan encourages the development of an infrastructure that supports economic growth. ▪ The plan recognizes freight movement as a key component of infrastructure, which is an important component of economic development through value-added activities such as manufacturing, distribution, warehousing, and transporting of products. ▪ According to the plan, the composition of freight movements in AZ emphasizes the need for a strategy that adds value to the pass-through commodities. ▪ Increasing exports from AZ produces is one way to correct this supply chain imbalance and would attract freight-related business to the state. ▪ Multimodal inland ports are labeled as "promising" avenue. AllianceTexas is mentioned as an example.

Report Name	Year	Prepared by/for	Brief Summary	Freight-Related Key Findings
Pima County Economic Development Plan	2015	Pima County	The 2015 through 2017 Economic Development Plan is designed to guide the County's investments and policy actions to grow the local economy, increase jobs and income, and increase overall community wealth. The plan consists of 14 chapters, each of which focuses on an area of economic development and job creation/growth where the County can lead, directly affect and/or influence progress and outcomes. The 14 focus areas are: Primary Job Center Development, Regional Infrastructure Investment for Job Creation, Protecting Our Existing Major Employment Base, Logistics Center at TIA Environs, Leveraging Intellectual Capacity of Higher Ed., Promoting Tourism, Mining – Modernizing a Traditional Industry, Enhancing Our Relationship with Mexico, Enhancing Our Relationship with Canada, Enhancing Our Relationship with E. Asia and South Korea, Downtown Enhancement, Job Training and Employment Base Development, Economic Development Role in Ending Poverty, and Investing for an Economically Competitive Future.	▪ Primary job center development areas center around the Aerospace, Defense and Technology Business and Research Park; Sunset Road and I-10, River Road; Downtown; and biotech on Ajo, in Oro Valley, and at the UA Tech Park. ▪ The plan promotes regional infrastructure investment, including: the Sonoran Corridor (also referred to as the Auxiliary Interstate Highway), the Aerospace Parkway, SR 189, 2nd TIA runway, and rail/truck interface at the POT. The County is also investing in utility research and development south of Raytheon for future developments. ▪ The Plan emphasizes the need to support the stability and job growth of the region's largest employers: DMAFB, AZ ANG, Raytheon, and the UA. ▪ Recommends continued planning with PAG, RTA, TAA, Union Pacific and others, the development of a major logistics center for the Southwestern United States in the vicinity of TIA. ▪ Recommends continued improvement of surface transportation accessibility to warehousing and distribution centers associated with logistics in the TIA area, including a new auxiliary interstate highway connecting I-10 and I-19. ▪ Recommends supporting and advocating with FHWA and ADOT for the designation of heavy haul freight routes from BPOEs to the POT. ▪ Recommends cooperating with and assisting the POT in expanding their rail-to-rail and rail-to-truck intermodal operations as a true international inland port. ▪ Recommends continuing our effort with Sun Corridor Inc. and PAG to assist the Maquiladora industry in Sonora, Mexico in developing local, more reliable supply chains for materials and manufacturing-related services. ▪ The logistics opportunities represented by large scale transportation investments promote the region as an interstate and international trade and freight hub centered on Tucson International Airport with its access to surface, rail and air transportation.

Appendix 4

Developments in Autonomous Trucking Technologies

Appendix 4 provides an overview of the companies and technologies driving the development of autonomous trucking technologies, as well as the potential impacts on the trucking industry.

Autonomous commercial freight carriers may be the first driverless vehicles the public observes on U.S. highways due to the large proportion of driving time that trucks spend on highways, and the economic and safety gains possible from an autonomous trucking fleet. Highways generally allow for vehicles to travel at a constant speed without the need for complex maneuvering or pedestrian interaction. The monotony of this type of travel and the physical discomfort of driving for long hours on highways far from home have partially contributed to the current and growing worker shortage in the professional trucking industry. Autonomous vehicle (AV) features may allow drivers to rest or focus on other tasks instead of continuously focusing on driving in the short term, making the profession more attractive while potentially increasing safety and efficiency.

Autonomous trucking innovation leaders

Several companies have reached the testing phase in developing autonomous trucking technologies for transporting freight.

Daimler AG: On May 5, 2015, Daimler's Freightliner Inspiration Truck became the first autonomous commercial vehicle to operate on an open public highway in the United States as it conducted a demonstration ride in Nevada.[1] Daimler expects to begin introducing its autonomous truck commercially around 2025.[2]

Ottomotto LLC (Uber): Ottomotto LLC (Otto) made international news in October 2016 with a demonstration project in which a tractor-trailer truck drove 120 miles of interstate in Colorado, from Fort Collins to Colorado Springs, using an autonomous driving system.[3] For the cost of approximately $30,000 per truck, the San Francisco–based company later began offering autonomous retrofits for freight trucks built since 2013, when automatic transmission first became widespread in freight trucks.[4] Uber Technologies Inc. purchased Otto in the summer of 2016. Since the purchase, Uber's focus reportedly has drifted from further development of the self-driving truck technology,[5] with leadership instead opting to direct the acquired personnel and technology toward self-driving cars and Uber Freight, the company's mobile freight brokerage service. Uber is involved in ongoing litigation with Google over autonomous driving

[1] Freightlinerinspiration.com
[2] Stewart, J. (2016, May 17) $30K Retrofit Turns Dumb Semis into Self-Driving Robots. *Wired.com*.
[3] Davies, A., (2016) Uber's Self-Driving Truck Makes its First Delivery: 50,000 Beers. *Wired.* Oct. 25, 2016, available at https://www.wired.com/2016/10/ubers-self-driving-truck-makes-first-delivery-50000-beers/ (last visited October 24, 2017).
[4] Stewart, (2016).
[5] Harris, M. (2017, May 08) Has Uber Killed Off Its Self-Driving Trucks? *Wired,com. available at https://www.wired.com/2017/05/has-uber-killed-off-its-self-driving-trucks/*

technology that the founders of Otto, all former Google employees, allegedly stole from Google and provided to Uber when it purchased the company.[6]

Pelaton Technology: Pelaton is an automated trucking technology company developing truck platooning technology. [7] The current phase of the technology offers SAE Level 1 automation (see SAE designation table later in this appendix). Two trucks with platooning capabilities may connect on highways. The trailing truck then mimics the lead drivers accelerating and braking through vehicle-to-vehicle connection, allowing the trailing truck to follow the lead truck at a much closer distance than would be safe for a driver operating his/her vehicle independently. This technology can result in significant fuel savings for both the trailing and lead truck. The company's technology is currently designed for only two trucks, and the trailing driver steers his or her own vehicle. Subsequent iterations of the technology, however, may involve additional trucks and increased autonomy for the trailing vehicle.[8]

Tesla, Inc: The electric car company, Tesla, has announced plans to unveil an electric semi truck that would likely have autonomous capabilities.[9]

TuSimple: TuSimple is an autonomous trucking company with offices in Beijing, China, San Diego, California, and Tucson, Arizona. The company acquired an autonomous vehicle testing permit from the California Department of Motor Vehicles in June 2017 and began long-distance test runs between Arizona and California in July. It plans to conduct an autonomous test run of one of its trucks between Phoenix and Tucson in 2018.

Volvo: Volvo's new VNL series semi truck has a suite of SAE Level 1 autonomous features, including forward-collision warning, automatic emergency braking, lane departure warning and adaptive cruise control. Volvo also has developed prototypes of fully autonomous semi trucks.

Waymo (Google/Alphabet): Waymo, a subsidiary of Alphabet Inc., the holding company for Google, is considered the leader in autonomous driving technology. The company has recently begun exploring entering the autonomous trucking industry by developing technology to retrofit existing truck fleets.[10] Waymo is currently in litigation with Uber over proprietary autonomous driving technology that it alleges a former employee illegally obtained and shared with Uber.

Statutes and Regulation

While plenty of room still exists for improvements in self-driving technologies, barriers to technological advances—such as those posed by the need for driving regulations and by public

[6] Lafrance, A. (2017, February 17) A Doozy of a Lawsuit Over Self-Driving Cars. *The Atlantic.* available at https://www.theatlantic.com/technology/archive/2017/02/waymo-vs-otto-aka-google-vs-uber/517683/
[7] Peloton-tech.com
[8] [ATA] American Trucking Association Technology and Maintenance Council, Future Truck Program, Automated Driving and Platooning Task Force (2015) White paper: automated driving and platooning issues and opportunities. Sept. 21, 2015.
[9] Adams, E. (2017) Even Elon Musk may not be able to make an electric truck work, *Wired*, available at https://www.wired.com/2017/06/elon-musk-tesla-semi-truck-battery/. Accessed October 24, 2017.
[10] Stewart, J. (2017). Of course Google's Waymo is building self-driving trucks, *Wired,* June 2, 2017, available at, https://www.wired.com/2017/06/course-googles-waymo-building-self-driving-trucks/. Accessed October 24, 2017.

perception—may prove a larger hurdle for full implementation of AV on the nation's roads. Recently, however, regulatory efforts intended to address penetration of AVs into the market have accelerated, both nationally and at the state level.

In September 2017, the National Highway Traffic Safety Administration (NHTSA) released *Automated Driving Systems: A Vision for Safety*. This document serves as a guide to the AV industry without imposing actual regulations. It also provides guidance to state legislatures looking to create state-specific legislation to address AV technology. AV technology used in commercial trucks, referred to as CMVs by NHTSA, is regulated by the Federal Motor Carrier Safety Administration (FMCSA), not NHTSA, so commercial trucks fall outside the scope of the NHTSA guidance.

The U.S. House of Representatives passed the SELF DRIVE (Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution) Act with bipartisan support in September 2017, the same month as the release of the new NHTSA guidance, to address the patchwork of state legislation currently governing AV testing and deployment. The bill also accelerates the number of vehicles granted exemptions from Federal Motor Vehicle Safety Standards (FMVSS) per year from the current 2,500 to 100,000 by the third year of the act. As of this writing, the Senate is debating its version of the House bill, S. 1885. Both the House and Senate version of these bills specifically exclude commercial vehicles, including commercial trucks, from the legislation.[11]

Federal Motor Carrier Safety Regulations (FMCSRs), 49 C.F.R. 300 et seq., control the safety features required for commercial trucks. Transportation technology companies that wish to test or market trucks with autonomous technologies that obviate the need for safety requirements designed with the human driver in mind must request a waiver or exemption from one or more FMCSRs. To obtain a waiver, the requestor must show "one or more of the FMCSRs would prevent [the requestor] from using or operating CMVs or make it unreasonably difficult to do so, during a unique, non-emergency event that will take no more than three months to complete."[12] An exemption applies "if one or more FMCSRs prevents [the requestor] from implementing more efficient or effective operations that would maintain a level of safety equivalent to or greater than the level achieved without the exemption."

Arizona has taken action in an attempt to establish itself as an AV technology leader. In August 2015, Arizona Governor Doug Ducey signed Executive Order 2015-09. The order directs the state departments of transportation and public safety to support testing and operation of self-driving vehicles, and it permits pilot program partnerships between AV companies and the state's universities. The order also established the Self-Driving Vehicle Oversight Committee, which had its first meeting in August 2016.

The executive order coincided with an announced partnership between Uber and the University of Arizona. Waymo chose the Phoenix metro area as the first location for its Early Riders

[11] Eno Center for Transportation (2017), Section-by-section comparison of House and Senate autonomous vehicle bills

[12] [FMCSA] Federal Motor Carrier Safety Administration (2014) FAQs, "When may I request a waiver/exemption?" available at https://www.fmcsa.dot.gov/faq/when-may-i-request-waiverexemption. Accessed November 7, 2017.

program that gives area residents everyday access to the company's fully autonomous mini-vans, although a test driver stands ready to take control of the vehicle at all times.[13] Transportation technology companies are also testing autonomous trucks on Arizona's roadways. In July 2017, autonomous trucking company TuSimple completed a test run of one of its vehicles from San Diego to Yuma. The company plans to conduct another test run, from Tucson to Phoenix, in 2018.

Technologies Underlying AV

Current autonomous trucking technology includes, at a minimum, a combination of short-range radar, long-range radar and/or LIDAR (Light Detection and Ranging) and a video camera system:[14]

- *Radar:* The radar system provides continuous monitoring of vehicle distance from foreign objects. Vehicles currently in the testing phase use both short- and long-range radar. Short-range radar detects near objects (230-foot range) at a wider range of vision (130 degrees) by transmitting radio waves and measuring the waves as they reflect back from objects. Long-range radar detects more distant objects (820-foot range) with a narrower field of vision (18 degrees).[15]
- *LIDAR (Light Imaging Detection and Ranging):* LIDAR performs largely the same role as radar using lasers instead of radio waves. LIDAR is a developing technology that offers benefits over radar through more frequent measurements at a superior range.[16] LIDAR historically has cost significantly more than radar technology, but recent innovations in LIDAR offer the potential to lower costs and spur adoption in future autonomous vehicle systems.[17]
- *Camera system:* A video camera system installed on the truck detects lane markings as well as other vehicles and pedestrians to keep the autonomous truck in its lane and avoid collisions. [18]

Future autonomous trucks may adopt additional technologies to augment or replace the technologies described above.

- *Dedicated Short-Range Communications (DSRC):* In 1999, the Federal Communications Commission designated the 5.9 DSRC range for use in intelligent transportation systems.[19] This technology allows for rapid data-transmission rates, but it has a limited range of 1,000 meters. Potential application of this technology in autonomous trucking

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[13] Waymo, "Early Riders," available at https://waymo.com. Accessed November 7, 2017.
[14] Short and Murray, 2016
[15] Id*.*
[16] Metz, C. (2015, Sept. 3). Laser Breakthrough could Speed the Rise of Self-Driving Cars. *Wired.com*. Accessed July 20, 2017.
[17] Metz, 2015.
[18] Short and Murray, 2016.
[19] Short and Murray, 2016; Federal Communications Commission*. FCC Allocates Spectrum in 5.9 GHz Range for Intelligent Transportation Systems Uses*. [Press release]. October 21, 1999. https://transition.fcc.gov/Bureaus/Engineering_Technology/News_Releases/1999/nret9006.html.

technology includes vehicle-to-vehicle (V2V) as well as vehicle-to-everything (V2X) technologies.[20]

- *5G:* High-speed wireless communications platforms have the potential to serve the same function as 5.9 DSRC. The current level of technology, 4G long-term evolution (LTE), provides a superior range but inferior data transfer rates compared with 5.9 DSRC. However, the next generation of high-speed wireless communications, 5G, which is at least three years away from widespread implementation,[21] promises speeds 10 to 100 times faster than currently available technology.
- *Differential Global Positioning System (DGPS):* DGPS technology offers a potential improvement over traditional GPS technology by adding ground-based correction stations that act as a third reference point between an autonomous vehicle and a satellite. The increased accuracy offered by DGPS could maintain autonomous vehicles in their travel lanes even in the absence of lane markings.
- *Luneburg lenses:* Scientist at the University of Arizona have recently licensed technologies to improve on current autonomous vehicle systems.[22] The technologies rely on inexpensive, high-performing, 3-D printed "Luneberg lenses," which date back to the 1940s. These lenses, combined with embedded electronics and insulating layers, allow for a full 360-degree sensor range. The lenses are intended to replace the multiple, more expensive sensors such as LIDAR and cameras that have limited ranges and are sensitive to adverse weather conditions.

AV Technology Applications

The Society of Automotive Engineers (SAE) International indentifies and defines six levels of driving automation to characterize AV technologies, ranging from "no automation" to "full automation" (see following table). The SAE classification has emerged as the widely accepted standard for classifying levels of driving automation, including use in the NHTSA's newly released safety guidelines pertaining to automated driving systems. The classifications are descriptive rather than normative, and technical rather than legal.

[20] Short and Murray, 2016.
[21] Wire Staff. (2017, Feb. 2) What is 5G, and When Do I Get It?, *Wired,* available at www.wired.com/2017/02/what-is-5g-and-when-do-i-get-it/.
[22] Wichner, D. (2017) Startup at UA could lower ocst of self-driving vehicles. *Arizona Daily Star*. September 21, 2017. A13.

SAE Level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability (*Driving Modes*)
***Human driver* monitors the driving environment**						
0	**No Automation**	full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	*driving mode*-specific execution by a driver-assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	*driving mode*-specific execution by one or more driver-assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that *the human driver* perform all remaining aspects of the *dynamic driving task*	System	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	*driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	System	Human driver	Some driving modes

SAE Level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability (*Driving Modes*)
4	**High Automation**	*driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	All driving modes

Source: SAE International, Standard J3016

The following list of technologies provides an overview of AV applications that trucking industry leaders[23] predict will become commercially available within the next 10 years:

Automated Movement in Queue: Similar to traffic jam assist systems, this system would allow drivers to switch into autonomous mode when waiting in line at their destination. Trucks would likely use the system off public roads, making the human driver's constant attention less of a necessity and possibly allowing him/her to exit the vehicle upon placing the vehicle in queue.

- SAE level: 3
- Estimated commercial availability: 2018–2020

Automated Off-Highway Material Hauling: Autonomous commercial trucks and hauling equipment are currently in use in private facilities such as mining sites and shipping yards.

- SAE level: 4
- Estimated commercial availability: currently available

Automatic Trailer Backing: This function automatically reverses a commercial truck to back a trailer into a loading port. The function would be used at the vehicle origin or destination. Steering a trailer in reverse is one of the most difficult tasks required of a truck operator. Automating this task may allow potential drivers to obtain operator licenses more quickly, thereby addressing the industry's worker shortage.

- SAE level: 2
- Estimated commercial availability: 2018–2020

Truck Platooning: This technology allows a leading and a trailing driver to link during highway driving using V2V communication. By synchronizing braking and acceleration, a trailing truck may follow a leading truck at a much closer distance than a human driver could safely operate a trailing vehicle. This reduction in following distances creates significant fuel-efficiency gains for both the leading and trailing trucks through streamlining. The gains reduce fuel consumption, one of the industry's largest expenses, and result in reduced localized air pollution and carbon emissions. Vehicles traveling at shorter following distances will also reduce traffic congestion by occupying less roadway space with the same number of vehicles.

Initial commercial use of platooning will be limited to two vehicles with both the lead and trailing drivers maintaining control of vehicle steering. As commercial use of platooning matures, the size of platoons will increase, and the use of the technology will become more automated. Eventually, a single lead driver may be the only human operator required for a platoon of trucks. The maximum size of a platoon may face limitations due to constraints posed by infrastructure, such as bridges, on/off ramps and roundabouts.

- SAE level: 1–5
- Estimated commercial availability: 2017–2018 (Level 1) 2020-2022 (Level 2)

[23] Time frames represent the estimates of ATA (2015).

Highway Pilot: This system provides lane assistance and automatic braking and acceleration in high-speed highway environments. For the initial rollout of the technology, the driver must maintain attention to the driving environment at all times while highway pilot is in use. A sensor may monitor the driver to ensure the driver maintains eye contact with the driving environment. The initial version of the technology also would maintain the vehicle in a single lane. Subsequent iterations of the technology may have lane-change capabilities and allow the driver to remove his/her attention from the road. In the long term, applications of the highway pilot technology could extend to the introduction of fully autonomous highway vehicles.

- SAE Level: 2–5
- Estimated commercial availability: 2018–2020 (Level 2)
2020–2023 (Level 3)

Traffic Jam Assist: A system that takes over driving operations in congested, low-speed situations. The system automatically breaks and accelerates, as well as provides steering assistance. When traffic speeds reach a certain level, around 30 miles per hour, the system automatically shuts off, and the driver must take control.

- SAE level: 2
- Estimated commercial availability: 2017–2019

Other Freight Technology Innovations

This section reviews non-AV technological innovations likely to impact the freight industry in years to come.

Infrastructure

Freight often travels along specific corridors as it moves from ports or major supply centers to the interstate system and toward its final destination. The ability to move freight efficiently through these corridors has significant public and industry implications. Braking and accelerating at traffic intersections strains roadways, causing pavement to degrade at a faster rate (braking), and increases air pollution emissions (accelerating). Time delays from traveling along congested corridors increases costs to industry, and trucks that take alternative routes to avoid congestion present a nuisance and safety concern to local residents, especially pedestrians.

Vehicle-to-infrastructure (V2I) technology has the potential to allow freight traffic to move more efficiently along designated corridors. Although additional applications of V2I technology are possible with respect to commercial vehicle traffic, the most immediate impact from V2I would be the ability to prioritize freight traffic in the traffic signal cycle through an Adaptive and Advanced Signal Control System (AASCS).[24] Signal prioritization would benefit from more widespread implementation of DSRC technology. Emergency vehicles have used signal

[24] Morgan, et al., 2017.

prioritization for years, with alternative technical approaches. Cost of implementation and the personnel and maintenance required to maintain operation present the greatest barriers to AASCS implementation.[25]

The infrastructure requirements for emerging AV technologies remain uncertain. V2I connectivity may prove essential for a transportation system based on AV technology. AV systems currently under development, however, function independently of any particular infrastructure installed specifically for automation.[26]

Freight Delivery Brokers

Freight brokers match truck drivers with freight loads. These brokers traditionally have taken a commission of approximately 12 percent from drivers, and drivers often experience lengthy delays between completing a delivery and receiving payment. Advances in information technology and the use of mobile applications are disrupting the traditional freight brokerage model. Uber Technologies (Uber), and some established freight brokerage companies have introduced mobile applications that allow truck drivers to connect directly with shippers. Uber Freight, which began offering its services to major markets in Texas in May 2017, offers drivers the ability to select loads, using the mobile application, sorted by destination, deadline and required special equipment.[27] Uber Freight promises upfront pricing, lower commissions and payments to drivers within seven days of delivery.

First-Mile/Last-Mile Delivery

The shift of retail sales from traditional “brick and mortar” establishments to online shopping and at-home delivery over the last decade has resulted in an increase in last-mile, at-home freight deliveries. Traditional parcel delivery services can increase traffic congestion and decrease air quality through heightened emissions. Unmanned aircraft systems (UASs), commonly referred to as drones, have the potential to abate these problems by transporting low-weight freight items in the largely unused airspace below 500 feet. As of this writing, Amazon and Alphabet Inc.’s X (formerly Google X) are leading testing and development efforts of UASs. Ultimately, these and other companies hope to provide at-home delivery of goods to end-users within minutes of consumer delivery orders being placed. This scenario faces significant regulatory barriers in the United States, and it would likely prove unworkable under the current air-traffic control model for directing and regulating commercial flights, considering the anticipated high volume of UASs upon full adoption.[28] Full development of this technology would likely require a new regulatory framework for air travel below the civil airspace boundary of 500 feet.

[25] Id.
[26] ATA, 2015
[27] Davies, A. (2017) With Uber Freight, Travis takes on trucking, *Wired*, available at https://www.wired.com/2017/05/uber-freight/. Accessed November 8, 2017.
[28] Amazon Inc. (2015) “Revising the airspace model for the safe integration of sUAS”

Industry Implications

Each year, the American Transportation Research Institute (ATRI) asks members of the trucking industry to list their top concerns facing the industry and, each year, issues concerning drivers feature prominently among the results. In 2016, five of the top 10 concerns expressed by the industry, including the top two, directly related to the impact on the industry of regulation on truck drivers' operating hours and overall labor shortages.[29] This finding is consistent with the concern expressed over driver-related issues in previous ATRI surveys.[30]

First among these concerns are hours-of-service limitations placed on the trucking industry.[31] These restrictions limit the time a driver may continuously operate a vehicle before taking a break and the total number of hours a driver may operate a vehicle in a week.[32] Other industry concerns include a national driver shortage, a low driver-retention rate and distracted driving.[33] In addition to addressing such concerns, autonomous driving has the potential to dramatically increase trucking safety. The Federal Motor Carrier Safety Administration's "Large Truck Crash Causation Study" determined that 89 percent of all trucking crashes it analyzed that resulted in at least one injury or fatality were the result of human error.

While the potential exists for automation to supplant human drivers entirely, this development would require significant leaps in trucking technology and the regulation and public perception surrounding it. In the near term, however, AV technologies can increase the attractiveness of the profession to drivers while improving safety and increasing the efficiency of freight delivery. More advanced autonomous features may allow drivers to concentrate on other tasks, such as logistics work or sleeping.[34] These autonomous features would address the monotony drivers experience from continually focusing their attention on driving. Removing the need for that constant human attention may also allow for increased flexibility in time-of-service regulations or render them unnecessary.

As highway pilot technology matures, a human operator may only need to drive the truck from a loading point to a highway entrance, at which point the driver could potential switch the truck into autonomous mode for the majority of the journey until it needed to exit the highway near its destination.[35]

This scenario would potentially address all the major, driver-related issues facing the trucking industry.[36] Once on the highway, autonomous trucks would not need to adhere to the hours-of-service limitations placed on human drivers. Autonomous vehicles are obviously not vulnerable to the fatigue, distraction or inebriation to which human drivers are vulnerable, resulting in safer

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[29] American Transportation Research Institute (ATRI). (2016). *Critical Issues in the Trucking Industry – 2016*. Arlington, VA.
2015.
[30] ATRI, 2016
[31] Id.
[32] Short and Murray, 2016.
[33] ATRI, 2016.
[34] Id.
[35] Short and Murray, 2016.
[36] Id.

and more efficient freight transport. Furthermore, if drivers could release a truck into autonomous mode at the highway entrance near the freight loading point, they could avoid long periods of time away from home, making trucking a more attractive profession.[37] This change to the nature of the profession could potentially address driver shortage and retention issues.

[37] *Id.*

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Appendix 5

Critical Urban Freight Corridors Identification Methodology

Background and Purpose

The following summarizes the methodology used for identifying Critical Urban Freight Corridors (CUFCs) as described in 23 U.S.C 167(c) and (f). According to the code, Pima Association of Governments (PAG), as the federally designated metropolitan planning organization (MPO) representing an urbanized area with a population of more than 500,000, may designate, in consultation with Arizona Department of Transportation (ADOT), a public road within the boundary of the Tucson urbanized area as a CUFC. A road, once designated, will become part of the National Highway Freight Network (NHFN) making projects on the corridor eligible for funding under the National Highway Freight Program (NHFP) and Fostering Advancements in Shipping and Transportation for the Long-term Achievement of National Efficiencies (FASTLANE) competitive grants program.1

The State of Arizona may designate a maximum of 102.56 centerline miles of roadways as CUFCs. Following discussions with ADOT and the Maricopa Association of Governments, PAG is anticipating an allocation of 30 miles for the Tucson urbanized area.

To be eligible to receive CUFC designation, a roadway must meet one or more of the following four elements:

(A) Roadway connects an intermodal facility to the Primary Highway Freight System (PHFS), the Interstate System or an intermodal freight facility.

(B) Roadway is located within a corridor of a route on the PHFS and provides an alternative highway option important to goods movement.

(C) Roadway serves a major freight generator, logistic center, or manufacturing and warehouse industrial land.

(D) Roadway is important to the movement of freight within the region, as determined by the MPO or the State.

[1] In August 2017, the FASTLANE program became known as Infrastructure for Rebuilding America (INFRA).

Corridor Identification Approach

PAG used an eight-step, score-based, GIS and travel-demand modeling approach to rank potential roadways for CUFC designation. The tables below show the criteria and weighting used to conduct an initial screening of the network for CUFC candidate routes.

1. Urbanized area boundary

The first step of the process was to eliminate corridors that fall outside of the Tucson urban area (UZA) boundary.

Element	Score
Roadway is within the Tucson UZA	Move on to step 2
Roadway is outside of the Tucson UZA	Eliminate from Consideration
Data needs: Census UZA boundary	

2. Freight volumes

Truck volumes on regional corridors were estimated using TRANSEARCH routing data. Scores were assigned based on natural breaks in the numbers as determined by ArcGIS.

Element	Score
300 freight trucks per day or more	10
125-299 freight trucks per day	6
40-124 freight trucks per day	4
Fewer than 40 freight trucks per day	0
Data source: TRANSEARCH roadway freight truck volume data	

3. Freight value

The values of truck commodities moving on regional corridors were then estimated on regional corridors using TRANSEARCH routing data. Scores were assigned based on natural breaks in the numbers as determined by ArcGIS.

Element	Score
$4.5 million freight value per year or more	10
$2 million-$4.49 million freight value per year	6
$500,000-$1.99 million freight value per year	4
Less than $500,000 freight value per year	0
Data source: TRANSEARCH roadway freight truck value data	

4. Stakeholder identified routes

Stakeholder routes were those identified by the Freight Plan task force at the Freight Plan kick-off meeting in August 2016. Weighting was increased in scenarios described In the CUFC Review section at the end of this appendix.

Element	Score
Identified at three tables	6
Identified at two tables	4
Identified at one table	2
Not identified at any tables	0

5. Connects an intermodal freight facility to an intermodal freight facility or an interstate

Corridors connecting the Port of Tucson to Tucson International Airport, or that connected either facility to the interstate, were assigned 10 points.

Element	Score
Connects a freight intermodal facility to the interstate or another freight intermodal facility	10
Does not connect an intermodal facility to the interstate or another intermodal facility	0
Data source: Intermodal Identification, GIS files identifying connections	

6. Corridor has needed improvements identified in the TIP or RMAP

Corridors identified for improvements in the recently adopted 2045 Regional Mobility and Accessibility Plan (RMAP) or Transportation Improvement Program (TIP) were given extra points. Their inclusion in the RMAP or TIP was used as an indication of improvement needs on the corridor.

Element	Score
Roadway has projects in the RMAP or TIP	10
Roadway has projects in the RMAP reserve list	5
Roadway has no projects associated with it	0
Data source: RMAP/TIP project database and reserve list	

7. Corridor not otherwise eligible for FASTLANE or NHFP funds

Corridors that would not otherwise be eligible for freight-specific funding (those located on an interstate or the National Highway System) were given a few additional points for consideration.

Element	Score
Roadway not eligible for funding because it is not currently on the NHS nor part of the NHFN	4
Roadway is eligible for FASTLANE but not NHFP funds	2
Roadway already eligible for both FASTLANE and NHFP funding	0
Data Source: NHS and Interstate roadways	

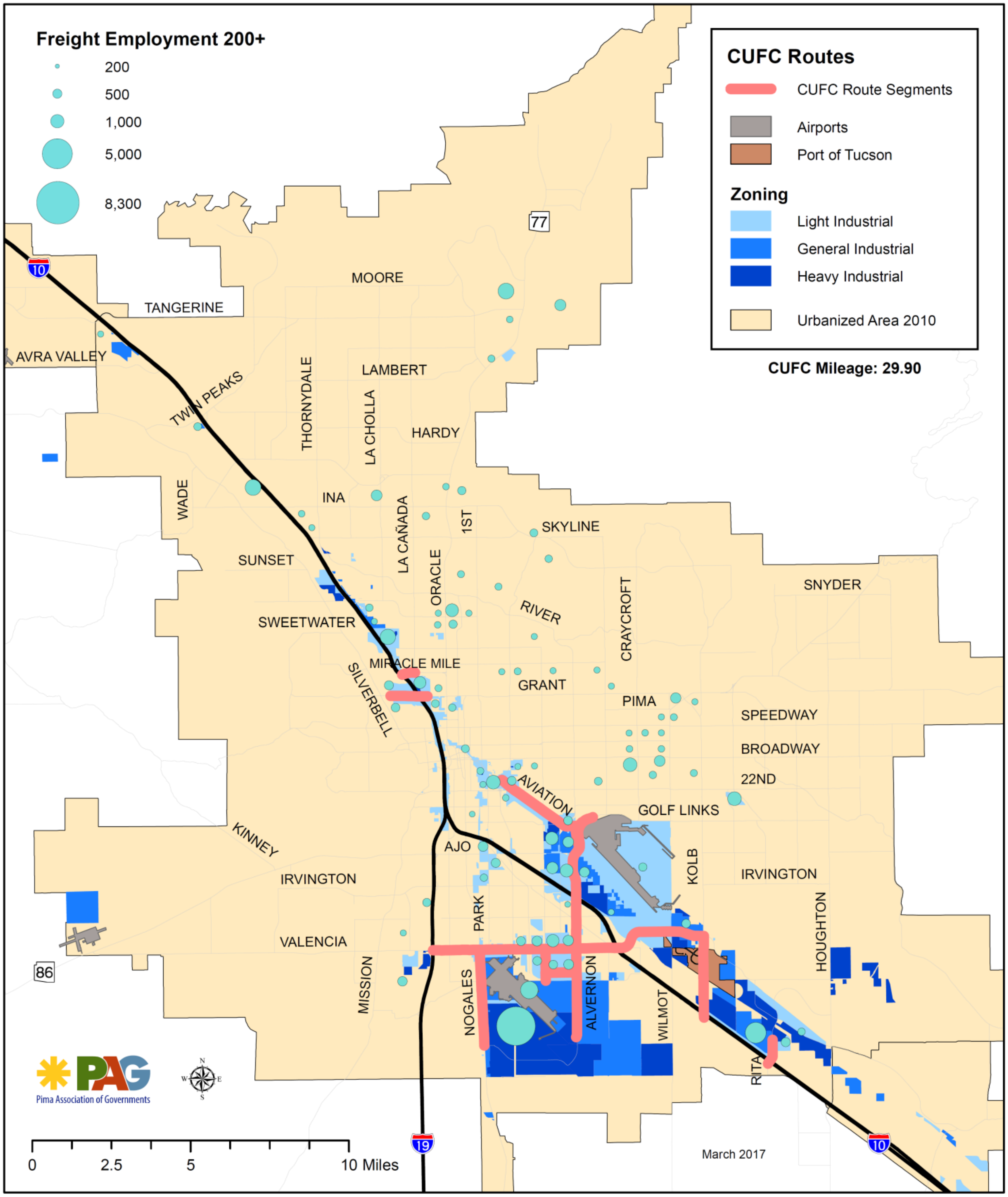
8. Connects to significant transportation/distribution/manufacturing cluster

In the last step, PAG overlaid top-scoring corridors on employment clusters of freight-intensive industries. This overlay allowed for visual verification that CUFC-nominated corridors are serving top freight-generating or top freight-receiving locations.

CUFC Review

Following PAG ranking of corridors using the criteria, two additional scenarios were developed. These scenarios applied different weighting for each of the criteria to emphasize stakeholder input. The Freight Plan task force reviewed the three scenarios and made recommendations. PAG incorporated input from the task force and determined the final 30-mile recommendation for CUFC routes. FHWA issued a finding of concurrence in May 2017, making official the CUFC network for the Tucson urban area. The 30-mile CUFC network, a table of the corridors, and FHWA's concurrence letter are included in this appendix. The CUFC network is included in the most extensive Regional Freight Corridor network developed for the Freight Plan.

Figure 1 Critical Urban Freight Corridors in the Tucson urban area



The following are the descriptions of the Tucson urban area's CUFCs.

Street/Corridor Name	Start Point	End Point	Length (in miles)
22nd Street	I-10	Aviation Parkway ramp	2.53
Alvernon Way	Hughes Access Road	Aviation Parkway	6.72
Aviation Parkway	22nd Street	Aviation Parkway - Golf Links Road	2.02
Aviation Parkway – Golf Links Road	Aviation Parkway	Golf Links Road	0.54
Benson Hwy	Campbell Ave	Irvington Road	0.61
Campbell Ave	I-10 EB on ramp (Exit 263 from south)	I-10 EB on ramp (Exit 263 from north)	0.30
Corona Road	Country Club Road	Alvernon Way	0.98
Country Club Road	Los Reales Road	Valencia Road	1.00
Golf Links Road EB	Alvernon Way	Golf Links Road	1.34
Grant Road	Silverbell Road	Flowing Wells Road	1.47
Kino Parkway	Benson Hwy	I-10 EB on ramp (Exit 263 from south)	0.27
Kolb Road	I-10 EB on ramp (Exit 270 from south)	Benson Hwy	0.24
Miracle Mile	I-10	Flowing Wells Road	0.41
Nogales Hwy	Hughes Access Road	Valencia Road	3.02
Rita Road	I-10 EB on ramp (Exit 273 from south)	Rita Access Road	0.79
Tucson Blvd	Valencia Road	Irvington Road	2.01
Valencia Road	I-19	I-10 EB on ramp (Exit 267 from west)	5.73
		Total length	**29.97**

Attachment 1 FHWA CUFC concurrence letter

U.S. Department of Transportation
Federal Highway Administration

ARIZONA DIVISION

4000 North Central Avenue
Suite 1500
Phoenix, Arizona 85012-3500
Phone: (602) 379-3646
Fax: (602) 382-8998
http://www.fhwa.dot.gov/azdiv/index.htm

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Pima Association of Governments

May 11, 2017

File:
TRAP 42 – Freight Corridors

Mr. Farhad Moghimi
Executive Director
Pima Association of Governments
1 East Broadway Boulevard, Suite 401
Tucson, Arizona 85701

~~Dear Mr. Moghimi:~~ Farhad

In accordance with 23 U.S.C. 167(g), the FHWA Arizona Division has reviewed the Pima Association of Government's Critical Urban Freight Corridor (CUFC) designation for the Tucson metropolitan area. The Arizona Division concurs that the designation meets the requirements of 23 U.S.C. 167(f).

Sincerely,

Karla S. Petty

Karla S. Petty
Division Administrator

ecc:
Greg Byres, Arizona DOT
Clem Ligocki, Arizona DOT
Heidi Yaqub, Arizona DOT
Mark Hoffman, Arizona DOT
Alan Hansen, FHWA Arizona Division
Jennifer Brown, FHWA Arizona Division
Ed Stillings, FHWA Arizona Division

Appendix 6

State and Jurisdictional Freight Regulations

Appendix 6 provides a catalogue of state and jurisdictional statutes and regulations in effect at the time of the Freight Plan's writing, affecting the operations of freight vehicles in Pima County. The appendix is organized by jurisdiction.

State of Arizona

28-1091. Violation; scope and effect

A. A person shall not drive or move and the owner of a vehicle shall not knowingly cause or permit to be driven or moved on a highway a vehicle or vehicles of a size or weight exceeding the limitations stated in this article or otherwise in violation of this article.

B. The maximum size and weight of vehicles specified in this article are lawful throughout this state. A local authority shall not alter the limitations stated in this article unless authorized by this article.

…

D. A law enforcement officer shall not issue a citation to or detain a motor carrier who does not have a permit issued by the department or a local authority if the motor carrier is on a street or roadway that is controlled by a local authority and all of the following apply:

1. The local authority does not issue permits pursuant to section 28-1103.
2. The motor carrier is unable to obtain a permit required by section 28-1103 from the department solely for the reason that the motor carrier is operating on streets and roadways that are under the jurisdiction of a local authority.
3. The motor carrier is in compliance with rules adopted by the department pursuant to section 28-1103 or ordinances adopted by the local authority that relate to the movement of overdimensional or overweight vehicles.

28-1092. Reasonable access; definitions

A. The department shall provide reasonable access to vehicles of legal size to and from terminals and service facilities within one road mile of the national network on highways within its jurisdiction.

B. The local authority shall provide reasonable access to vehicles of legal size to and from terminals and service facilities within one road mile of the national network on highways within its jurisdiction (exceptions apply)

…

G. For purposes of this section:

5. "Vehicle of legal size" means a vehicle of a size that meets the limitations described in section 28-1093, subsection C, section 28-1094 and section 28-1095, subsections A and B, subsection C, paragraphs 1 through 4 and subsection D.

28-1093. Vehicle width; exceptions

C. A person may operate a vehicle with a total width of the vehicle or the load on the vehicle of not more than **one hundred two inches**, exclusive of safety equipment, on:

1. Any segment of the national system of interstate and defense highways.

2. Any other qualifying federal aid highway.

3. Any state highway, as designated by the director.

4. Streets that are designated by a local authority.

28-1094. Vehicle height; exceptions; special permits

A. Without a permit issued under section 28-1103 or this section, a vehicle unladen or with a load shall not exceed a height of **thirteen feet six inches** above the level surface on which the vehicle stands.

28-1095. Vehicle length; exceptions; permits; rules; definitions

The following restrictions apply:

1. The length of a semitrailer operating in a truck tractor-semitrailer combination or a truck tractor-semitrailer-forklift combination shall not exceed **fifty-seven feet six inches**.

2. The length of a semitrailer or trailer operating in a truck tractor-semitrailer-trailer combination shall not exceed twenty-eight feet six inches.

3. The length of a trailer operating in a truck-trailer combination shall not exceed twenty-eight feet six inches.

4. If the length of a semitrailer is more than fifty-three feet, the overall length of a truck tractorsemitrailer combination shall not exceed sixty-five feet on all highways, except for the national intercity truck route network designated by the United States secretary of transportation as required by the surface transportation assistance act of 1982 or on a system of highways that is designated by a local authority. In designating the streets, the local authority shall consider any reasonable restriction including such safety restrictions as structural hazards and street width and any other safety factors identified by the local authority as a hazard to the motoring public.

5. A vehicle transporter and the semitrailer it draws shall not exceed a length of eighty feet with a front overhang of not more than four feet and a rear overhang of not more than six feet.

6. A truck-semitrailer combination shall not exceed an overall length of sixty-five feet.

28-1099. Single axle load limit; exceptions

A. **The gross weight imposed on the highway by the wheels of any one axle of a vehicle shall not exceed twenty thousand pounds**, except that:

1. The director may issue a special permit pursuant to section 28-1103 for the purpose of moving road machinery that exceeds the maximum weight specified in this section from job to job within this state and from job to place of servicing and return within this state.

2. Any over-the-road bus may exceed the maximum single axle weight limit but shall not exceed twenty-four thousand pounds. For the purposes of this paragraph, "over-the-road bus" means a bus characterized by an elevated passenger deck located over a baggage compartment.

B. This section does not limit in any manner the power of the director and a local authority to issue a special permit pursuant to section 28-1103.

C. For the purposes of this article, the gross weight imposed on the highway by the wheels of any one axle equals the total load transmitted to the road by all wheels whose centers are included between two parallel transverse vertical planes forty inches apart, extending across the full width of the vehicle.

28-1100. Vehicles and loads; gross weight restrictions; exceptions

A. Except as provided in subsection H of this section or section 28-1099, a person may operate a vehicle on all highways, including a toll facility as defined in section 28-7751, subject to the following maximum gross weights:

3**.** Eighty thousand pounds on a vehicle combination of five axles or more.

28-1103. Excess size and weight special permits; definition

A. Subject to section 28-1104, subsection E, on application in writing and for good cause, the director with respect to highways under the jurisdiction of the department and **a local authority with respect to highways under its jurisdiction may issue a special permit in writing authorizing the applicant to operate or move a vehicle or combination of vehicles of a size or weight of vehicle or load exceeding the maximum specified in this article or otherwise not in conformity with this chapter on any highway under the jurisdiction of the party granting the permit and for the maintenance of which the party is responsible.**

…

C. Subject to this section, the director or **local authority may issue the following special permits that are valid for thirty days or one year** and that may be limited by the director or local authority:

1. A special permit authorizing the applicant to transport a load by means of a truck-semitrailer, truck-trailer, truck tractor-semitrailer-semitrailer or truck tractor-semitrailer-trailer combination, if all of the following conditions are met:

(a) The overall length of the cargo carrying unit of the vehicle combination does not exceed ninety-five feet.

(b) The axle weight limitations are subject to sections 28-1099 and 28-1100.

(c) The overall gross weight of the vehicle combination does not exceed one hundred twenty-nine thousand pounds.

2. Except on the national intercity truck route network designated by the United States secretary of transportation as required by the surface transportation assistance act of 1982, a special permit authorizing the applicant to transport a load by means of a truck and two trailing units or a truck tractor, a semitrailer and two trailing units if all of the following conditions are met:

(a) The overall length of the cargo carrying unit of the vehicle combination does not exceed ninety-five feet.

(b) **The axle weight limitations conform to sections 28-1099 and 28-1100.**

(c) **The overall gross weight of the vehicle combination does not exceed one hundred twenty-three thousand five hundred pounds.**

F. If a local authority issues permits pursuant to this section, the local authority shall adopt and enforce ordinances that are substantially identical to rules adopted by the department that relate to overdimensional or overweight commercial vehicles, and the local authority may adopt ordinances relating to infrastructure restrictions, route restrictions and time-of-day restrictions. The local authority shall provide to the department in a timely manner in an electronic format prescribed by the director all current ordinances and rules of the local authority relating to the permits. The department shall notify the overdimensional permit council established by section 28-1150 of the ordinances and rules and make the ordinances and rules available to the public in an electronic format in a timely manner.

28-1106. Restriction on highway usage

C. A local authority with respect to highways under its jurisdiction may prohibit by ordinance or resolution the operation of trucks or other commercial vehicles or may impose limitations as to the weight of vehicles on designated highways. The local authority shall place appropriate signs on the highway to designate the prohibitions and limitations.

Pima County

10.36.010 - State provisions adopted.

The **state traffic laws regulating the size, weight and load of vehicles apply upon all county streets and highways, except in any incorporated city or town**. In the interest of public safety, certain limitations are imposed on the weight of trucks and other commercial vehicles on designated highways, and the operation of trucks and commercial vehicles on such designated highways is prohibited.

(Prior code § 35.40.010)

10.36.020 - Through truck defined.

The following definition, as used in this chapter, as amended, in addition to those in Section 10.04.020, shall apply in this chapter unless the context otherwise requires: Through truck means a truck or other commercial vehicle that does not turn off of or onto or stop along specified roadways for a reasonably purpose.

(Prior code § 35.40.020)

10.36.030 - Recommendation by engineer.

The county engineer shall recommend to the board of supervisors a reasonable and safe load limit or prohibition of trucks and other commercial vehicles on any designated highway. The board shall study such recommendation and shall approve, reject or modify the recommendation and shall note its action by ordinance or resolution.

(Prior code § 35.40.030)

10.36.040 - Effective upon posting.

All load limit ordinances approved by the board of supervisors shall take effect when and to the extent that signs are posted on the highways designated in this chapter giving notice thereof.

(Prior code § 35.40.040)

10.36.050 - Index.

The director of the department of transportation and flood control district shall keep an accurate listing of all prohibited through trucks and load limit restrictions designated by the board of supervisors and shall update the listing upon the removal or addition of new prohibited through truck or load limit restrictions by the board.

(Prior code § 35.40.050)

10.40.020 - State provisions adopted.

The state traffic laws regulating stopping, standing and **parking** apply upon all streets, highways and alleys within the county, except in any incorporated city or town.

(Prior code § 35.32.020)

Marana

12-3-12 Truck, trailer and recreational vehicle parking restrictions

A. Commercial trucks and oversized

Vehicles shall not be parked on a residential-area public street at any time, except while actively carrying on the activity for which the truck or vehicle is designed.

Oro Valley

11-3-5 Vehicle Weight Limitation

The maximum weight limitations for through traffic on roads within Oro Valley shall be as follows:

A. On **La Canada, between Lambert Lane and Naranja**, **five tons** per vehicle.

B. On **First Avenue between Tangerine Road and Lambert Lane**, **five tons** per vehicle.

C. On all other streets and roads, as is set forth in the applicable state statutes.

(00-22, Amended, 06/21/2000)

11-4-4 Nuisance Parking

6. **Parking Over-sized Vehicles.** No person shall park or store a commercially registered vehicle with a chassis rated for more than one (1) ton nor any vehicle greater than twenty-two (22') feet in length on streets or alleys in a residential area or zone except while loading, unloading, delivering, or making a service call at a residence.

11-6-1 Commercial Vehicles

A. **No person shall operate any commercial vehicle exceeding eighteen thousand (18,000) pounds** gross vehicle weight at any time upon any Town streets except those streets or parts of streets described in this section as **truck routes**; except as provided for in this section.

B. A person operating a commercial vehicle may leave an adopted truck route by the nearest route, and in so doing not crossing another truck route to make a **single delivery or pickup** after which they must return immediately by the nearest route.

(01-01, Added, 01/31/2001)

11-6-2 Truck Routes

A. Pursuant to ARS 28-627(A)(11) and within the reasonable exercise of the Oro Valley Police power, the following streets are hereby designated as truck routes: Oracle Road; Tangerine Road; Rancho Vistoso Boulevard; La Canada Drive, except that portion between Lambert Lane and Tangerine Road; First Avenue from Oracle Road to Lambert Lane; and Lambert Lane from First Avenue to La Canada Drive.

Pasqua Yaqui

Section 10 Traffic (8 PYTC § 6-4-10)

(A) Except as set forth in this Chapter, the Tribal Council of the Pascua Yaqui Tribe adopts as tribal law, the traffic laws of the State of Arizona as set forth in Title 28 of the Arizona Revised Statutes and any current and future amendments, with the following exceptions:

(1) All references in the Arizona law to the "State of Arizona", "Superior Court", or any related state agencies shall mean the corresponding authorities of the Tribal Government of the Pascua Yaqui Tribe.

(2) All references in the Arizona law to “local authorities”, “local authority” or “director” shall mean the Pascua Yaqui Tribal Council or their designee.

(3) Any Tribal laws, authorized by the Tribal Council of the Pascua Yaqui Tribe, and any future Tribal laws or regulations that are inconsistent with the traffic laws of the State of Arizona shall be treated as amendments to the Tribal Traffic Code established by this section.

(4) Nothing in this section shall prohibit the Tribal Council from enacting traffic laws in addition to or inconsistent with those passed by the State of Arizona.

(B) All interpretations of the Tribal Traffic Code established by this section will be consistent with Tribal government organization and structure. The Tribal Court will not be bound by sanctions stated in A.R.S. Title 28. The Tribal Court shall have full discretion regarding any sanctions imposed for violations of the Tribal Traffic Code established by this section.

Sahuarita

10.01.010 State provisions adopted.

All of the provisions and requirements of the Uniform Act Regulating Traffic on Highways, codified as ARS Title 28, in regard to the regulation of traffic and the use and operation of vehicles and amendments or additions thereto hereinafter enacted, insofar as such provisions can have application within the town, are adopted and made a part of this title as though fully set out herein.

10.30.010 Authority to restrict use.

The town council may, for the general health, safety and welfare of the town, restrict the use of certain streets by certain types or gross vehicle weight of vehicles. Such restrictions shall be adopted by ordinance. The town engineer shall have restricted streets properly posted with the restriction, town code section and potential maximum penalty for violation.

A. Weight Restricted Roadways. Weight restricted roadways within the town limits are as follows:

1. La Canada Road, between Duval Mine Road to El Toro Road, shall be restricted to vehicles with a gross vehicle weight (GVW), including trailers, not to exceed three tons, but exempting noncommercial vehicles, school buses, and vehicles with their destination or origin within or accessible only from the restricted area. [Ord. 2013-090 § 10; Ord. 1996-08 § 1; prior code § 12-6-1.]

10.30.020 Violations – Penalty.

Unless otherwise specified, a violation of this chapter shall be a civil traffic offense, punishable by a fine not to exceed $500.00. [Ord. 2013-090 § 10; Ord. 1996-08 § 1; prior code § 12-6-2.]

South Tucson

Sec. 14-102. Angle parking.

(c) It is unlawful for the driver of any vehicle stopped for the purpose of loading or unloading merchandise to park such vehicle or permit or allow such vehicle to remain parked at an angle to the curb or edge of the roadway except in an authorized freight curb loading zone by appropriate signs and markings for such purpose.

(Code 1976, § 8.149)

State Law References: Angle parking, A.R.S. § 28-874.

Tohono O'odham

TITLE 23 - TRAFFIC CODE CHAPTER 1 - TRAFFIC

NOW THEREFORE BE IT RESOLVED BY THE PAPAGO COUNCIL, that Section 66-151 through 66-401, 66-401, and 66-406 through 66-408 of Chapter V of the laws of the State of Arizona relating to Motor Vehicles be made applicable to the Papago reservations, except these provisions which by their nature can have no application, and that the above-listed sections be hereby adopted as an addition to Chapter V of the Papago Law and Order Code, becoming section 36 through 237 in consecutive order , PROVIDED , (1) That where the Arizona State Law reads "Department" "Commission : or "Local Authority," the corresponding sections of the Papago Law and Order Code shall read "Papago Council," "State," "County", "City", or "Village", shall read Papago Reservation," ; "Magistrate," or Justice of the Peace : shall read "Tribal

Judge" ; "County Jail" shall read "Tribal Court" ; Superintendent" of Highway Patrol" shall read "Chief of Indian Police" ; and "Patrol Officers," Police", or "Peace Officers" shall read "Indian Police", and (2)that where the Arizona State Law reads "misdemeanor" or "Felony" the corresponding section of the Papago Law and Order Code shall read "offense" . BE IT FURTHER RESOLVED : That Section 3, "Reckless Driving" of Chapter V of the Papago Law and Order Code and any other provisions thereof, pertaining to traffic laws, in conflict with this ordinance, be hereby repealed .

Tucson

Sec. 20-15. Truck routes established.

Within the incorporated city all streets identified as **arterial or collector streets in the Major Streets and Routes Plan**, adopted by Resolution 12340 and as amended, are hereby established as truck routes.

Sec. 20-15.1. Driving vehicles with a **gross vehicle weight rating** in **excess of twenty thousand (20,000) pounds** on streets not designated as truck routes prohibited; exceptions.

(a) All vehicles having a **total gross vehicle weight rating in excess of twenty thousand (20,000) pounds**, including, but not limited to, trucks, truck tractors, road tractors, trailers, semitrailers, vehicle transporters, or any combination of such vehicles, shall use only those streets established as truck routes. It is unlawful to drive any vehicle having a gross vehicle weight **rating in excess of twenty thousand (20,000) pounds** on a street not established as a truck route, except as provided in section 20-15.2 below, or where a permit has been issued by the chief of police, or that officer's designee, pursuant to the procedures set forth in section 2016.

(b) The director of transportation, or the director's designee, is **authorized to prohibit certain vehicles from using certain designated streets**, including truck routes, by the placement of appropriate signs limiting the gross weight of vehicles permitted to use those streets. However, the vehicles may use the streets designated under this section to make a delivery or pickup or to provide services to a property as permitted under section 20-15.2(b).

Sec. 20-15.2. Exceptions to truck route restrictions.

(a) Section 20-15.1 does not apply to **recreational vehicles.**

(b) A vehicle regulated under section 20-15.1 may:

 (1) Leave the truck routes by the shortest route to perform the following activities, after which it must return to the nearest designated truck route.

  (i) **Deliver, pick up, load, or unload** merchandise, materials, or equipment, including furniture and other household goods, except as prohibited under section 20-17; or

(ii) Provide construction, repair, or similar services to a property.

(2) Drive on any street within a **business district**, except as prohibited under section 20-15.1(b) or section 20-17.

Sec. 20-16. Special permission required to use streets not designated for trucks or to operate or move vehicles, loads or mobile homes exceeding state limitations; exemptions; permit and fee structure; violation a civil infraction.

(a) Except as may be otherwise specifically provided in subsection (b), where it is necessary for a vehicle whose use of city streets is regulated under section 20-15.1(a) to use a street not established as a truck route pursuant to section 20-15; or for any oversize or overweight vehicle, load, or mobile home to use any street, whether established as a truck route or not, that lies within the corporate limits of the city and that is not designated as a state highway**, application shall be made to the chief of police**, or that officer's designee**, for a permit for such use under police department supervision**, and no such use of streets as is set forth in this subsection shall occur, unless and until such permit is issued.

(b) A permit pursuant to subsection (a) is **not required in the following situations**:

(1) Where a vehicle whose use of city streets is regulated under section 20-15.1(a) engages in activities specifically authorized by section 20-15.2(b).

(2) Where the total maximum width of the vehicle, or of the vehicle and load, does not exceed one hundred two (102) inches, exclusive of safety equipment, and the operation or movement takes place solely on streets established as truck routes pursuant to section 20-15.

(3) Where the vehicle is exempted from size, weight and load limitations under A.R.S. section 28-1001(b), or any successor provision(s).

(c) The chief of police, or that officer's designee, is hereby authorized to issue the permits required under subsection (a). The **categories of authorized permits** shall be as follows: **single trip permits, mobile home permits, thirty-day permits, envelope permits, and annual permits. Permits to use a street not designated as a truck route shall be issued on a single trip or thirty-day basis only**. Envelope permits shall be issued on an annual basis only, and neither envelope permits nor single trip permits shall be issued for the movement of mobile homes. Any movement of a mobile home subject to the permit requirements of this section shall be undertaken as one continuous journey pursuant to a mobile home permit, which shall be valid for ninety-six (96) hours from the time of issuance.

(d) A person seeking any of the types of permits authorized under subsection (c) shall submit an application, accompanied by the corresponding fee as established in subsection (e). Such fees shall be waived for a vehicle, load or mobile home in governmental service. In addition, no fee shall be collected for a vehicle, load, or mobile home for whose operation or movement a valid permit has been issued by the state, a political subdivision of the state, or any other municipality, when the operation or movement of such vehicle, load, or mobile home terminates in or transits the city.

(e) Permit fees shall be as follows:

Type of Permit	Non Truck Route	Oversize	Overweight	Envelope
Single trip:	$15.00	$ 15.00	$ 25.00	--
Mobile home:	--	$ 15.00	$ 25.00	--
Thirty-day:	$30.00	$ 30.00	$ 50.00	--
Annual:	--	$240.00	$480.00	$600.00

Note: The fee for annual permits issued after January 31 of a calendar year shall be reduced by one-twelfth (1/12) for each full calendar month that has expired prior to issuance of the permit. Where a vehicle, load, or mobile home is both oversize and overweight, the permit fee shall consist solely of the overweight fee.

(f) Upon receipt of the application, and payment of any applicable fee, the chief of police, or that officer's designee, may grant the requested permit. The permit may restrict the use of any street, whether or not established as a truck route, or the operation or movement of any oversize or overweight vehicle, load, or mobile home, by day of the week, time of the day, route, or location within the city, and may set such additional restrictions as are necessary for public safety and convenience.

(g) All annual permits issued under this section shall expire at midnight on January 1 of the next calendar year, and persons seeking an annual permit for the new calendar year shall be required to submit a new application and permit fee.

(h) Any violation of the provisions of this section, specifically including, but not limited to, the failure to obtain a required permit or to comply with permit restrictions, is declared to be a civil infraction punishable by a mandatory sanction of not less than one hundred fifty dollars ($150.00), nor more than two thousand five hundred dollars ($2,500.00), no part of which shall be suspended or waived by the court.

(1953 Code, ch. 17, § 20; Ord. No. 8270, § 3, 11-21-94; Ord. No. 8958, § 7, 9-22-97)

Sec. 20-17. Districts where loading, unloading large vehicles prohibited; variances.

(a) No single-unit vehicle having more than two (2) axles or having an overall **length in excess of twenty-six (26) feet,** and no tractor-semitrailer having more than three (3) axles or having an overall **length in excess of forty (40) feet** shall be permitted to load or unload any packages of merchandise within that **district bounded on the north by the south and west line of Toole Avenue and Franklin Street, on the east by the east line of Fourth Avenue, on the south by the south line of Fourteenth Street and Cushing**

Street, and on the west by the west line of Granada Avenue, between the hours of 6:30 a.m. and 9:00 a.m., 12:00 p.m. and 1:00 p.m., and 3:30 p.m. and 6:00 p.m.

(b) The director of transportation, or the director's designee, may grant written **variances** from the provisions as set forth in subsection (a) provided:

(1) The nature of the merchandise being delivered is exceptional; or

(2) The nature of the business or service on the property is exceptional; and

(3) The applicant can conform to any required barricading and signing as set forth in section 25-24; and

(4) The variance is not against the public interest, safety, convenience or general welfare.

(1953 Code, ch. 17, § 21; Ord. No. 7157, § 1, 3-20-89; Ord. No. 10418, § 2, 6-12-07)

Sec. 20-18. Governmental vehicles exempt from truck route and loading or unloading provisions.

The provisions of sections 20-15 through 20-17 shall not be construed to prohibit the use of any street, alley or area of the city by vehicles of the United States Government, this state, county or city while in performance of their official or normal duties.

Sec. 20-262. Truck parking on streets not designated as truck routes prohibited.

(a) It is unlawful to park any vehicle having a total gross vehicle weight rating in excess of twenty thousand (20,000) pounds, including, but not limited to, trucks, truck tractors, road tractors, trailers, semi-trailers, vehicle transporters, or any combination of such vehicles:

(1) On a street not designated as a truck route under article I section 20-15 of this chapter; or

(2) On a street posted pursuant to section 20-15.1(b) with a sign or signs limiting the gross weight of vehicles permitted on the street; or

(3) Within a residence district.

(b) Notwithstanding the prohibition in section 20-262(a) above, a restricted vehicle may park, except as otherwise prohibited by this article:

(1) On any street within a business district, unless the street is posted pursuant to section 20-15.1(b) with a sign or signs limiting the gross weight of vehicles on the street; or

(2) On any street to perform the following activities, except that, upon completion of such activity, the vehicle must return to the nearest designated truck route:

(i) Deliver, pickup, load, or unload merchandise, materials, or equipment, including furniture and other household goods; or

(ii) Provide construction, repair, or similar services to a property.

(Ord. No. 9196, § 1, 1-25-99; Ord. No. 9492, § 3, 11-27-00; Ord. No. 11400, § 3, 9-20-16)

The table below provides a summary of size and weight limits and jurisdictionally defined truck routes

Weight limits and truck routes summary table

Jurisdiction	Length limit (in)*	Width limit (in)*	Height limit (in)*	Weight limit (lbs)*	Designated Truck routes	Weight limit off truck route (lbs)	Other routes with designated weight limits	Weight limit on "other routes" (lbs)
Arizona	690	102	162	80,000 (with exceptions)	Interstate highway system Any other qualifying federal aid highway State highways Streets designated by local authorities	Not applicable	None	None
Pima County	None Specified	None Specified	None Specified	None Specified	None	Not applicable	None	None
Marana	None Specified	None Specified	None Specified	None Specified	None	Not applicable	None	None
Oro Valley	None Specified	None Specified	None Specified	80,000 (with exceptions)	Oracle Rd Tangerine Rd Rancho Vistoso La Canada Dr (except for segment described below) 1st Ave (except for segment described below) Lambert Ln, b/t 1st Ave and La Canada	18,000	La Canada, b/t Labert Ln and Naranja 1st Ave, b/t Tangerine Rd and Lambert Ln	10,000
Sahaurita	None Specified	None Specified	None Specified	None Specified	None	6,000	La Canada, b/t Duvall Mine Rd and El Toro Rd	6,000
South Tucson	None Specified	None Specified	None Specified	None Specified	None	Not applicable	None	None
Tucson	None Specified	102	None Specified	80,000 (with exceptions)	All streets identified as arterial or collector streets in the Major Streets and Routes Plan	20,000	None	None

* Where a jurisdiction does not specify a truck weight or dimensional limitation, limitations default to those specified by the state.

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Appendix 7

Acronym Glossary

This glossary provides a list of transportation and agency acronyms used in the writing of Pima Association of Governments' Regional Freight Plan.

AADTT	Average Annual Daily Truck Traffic	**LiDAR**	Light Imaging Detection and Ranging
AASHTO	American Association of State Highway and Transportation Officials	**LPOE**	Land Port of Entry
ADOT	Arizona Department of Transportation	**LQ**	Location Quotient
ARC	Aerospace Research Campus	**MAG**	Maricopa Association of Governments
ATRI	American Transportation Research Institute	**MPO**	Metropolitan Planning Organization
BEA	Bureau of Economic Analysis	**MSA**	Metropolitan Statistical Area
BLS	Bureau of Labor Statistics	**NAICS**	North American Industrial Classification System
BNSF	Burlington Northern Santa Fe	**NCSA**	National Center for Statistics and Analysis
BPOE	Border Port of Entry	**NHFN**	National Highway Freight Network
CAG	Central Arizona Association of Governments	**NHFP**	National Highway Freight Program
CUFC	Critical Urban Freight Corridor	**NHS**	National Highway System
DMAFB	Davis-Monthan Air Force Base	**NMFN**	National Multimodal Freight Network
DSCR	Dedicated Short-Range Communications	**NPMRDS**	National Performance Management Research Data Set
EA	Environmental Assessment	**OS/OW**	Oversize/Overweight
EIA	Energy Information Administration	**PAG**	Pima Association of Governments
EIS	Environmental Impact Statement	**PTI**	Planning Time Index
ELD	Electronic Logging Device	**RFC**	Regional Freight Corridor
FAST Act	Fixing America's Surface Transportation Act	**RMAP**	Regional Mobility and Accessibility Plan
FASTLANE	Fostering Advancements in Shipping and Transportation for the Long-Term Achievement of National Efficiencies	**RTA**	Regional Transportation Authority
FCC	Federal Communications Commission	**SCMPO**	Sun Corridor Metropolitan Planning Organization
FHWA	Federal Highway Administration	**STSP**	Strategic Transportation Safety Plan

FMCSA	Federal Motor Carrier Safety Administration	**TAA**	Tucson Airport Authority
FRA	Federal Railroad Administration	**TAZ**	Traffic Analysis Zone
GDP	Gross Domestic Product	**TEP**	Tucson Electric Power
INFRA	Infrastructure for Rebuilding America	**TEU**	Twenty-Foot Equivalent Unit
IRI	International Roughness Index	**TI**	Traffic Interchange
JPAC	Joint Planning and Advisory Council	**TIP**	Transportation Improvement Program
TTI	Texas Transportation Institute	**UPRR**	Union Pacific Railroad
TTI	Travel Time Index	**USAF**	United States Air Force
TUS	Tucson International Airport	**USGS**	United States Geological Survey
USDOT	United States Department of Transportation	**VMT**	Vehicle Miles Traveled

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