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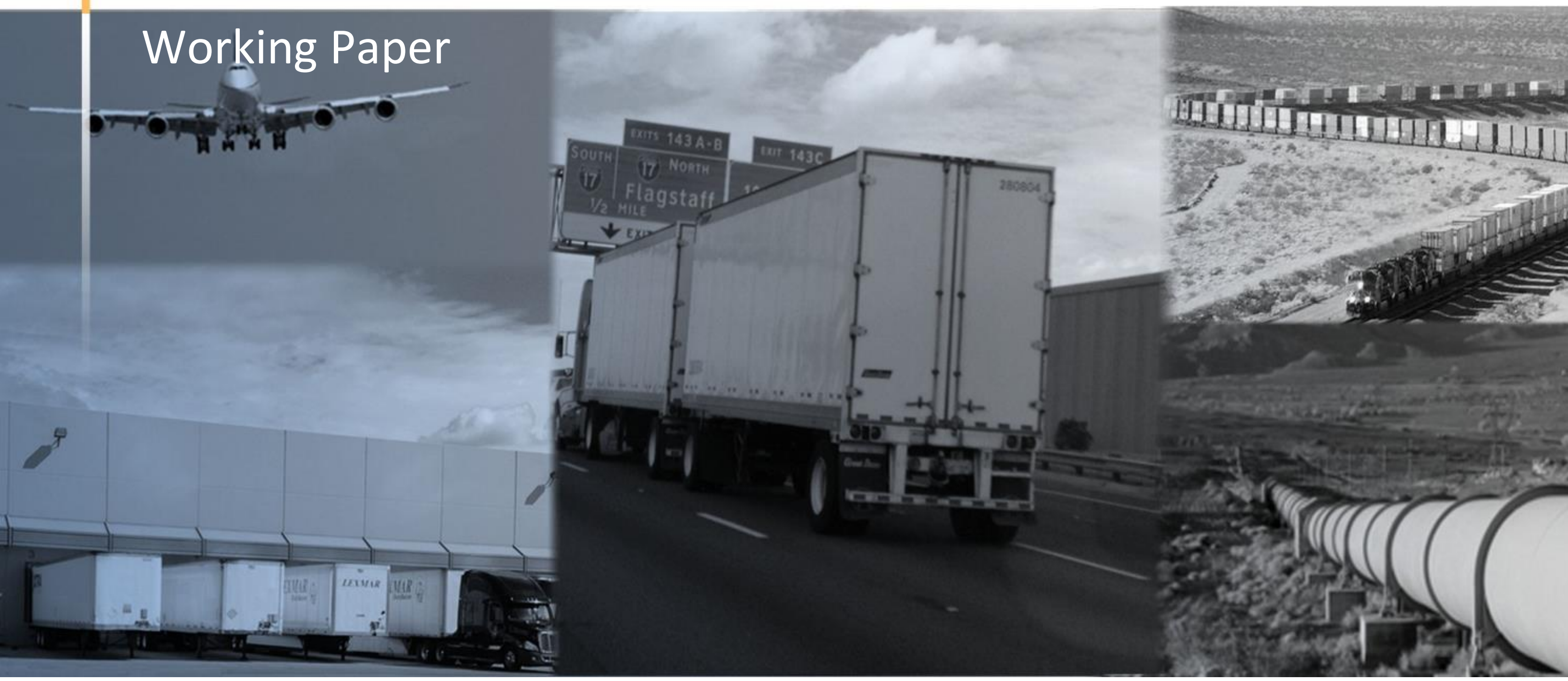

Arizona State Freight Plan

(ADOT MPD 085-14)

Phase 2 Working Paper
Inventory of State Freight Transportation System Assets

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Arizona Department of Transportation

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Solutions for growing economies

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Working Paper

This working paper is the output of Phase 2 (of 11) in the development of the Arizona State Freight Plan. It describes Arizona's multimodal freight transportation system—including highways, railways, air cargo airports, pipelines, and border crossings. Its purpose is to document the system's assets and facilities, current flows over the system, and how well it performs. This working paper is provided for comment and discussion and should not be interpreted as final.

Acknowledgements

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

Opinions

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

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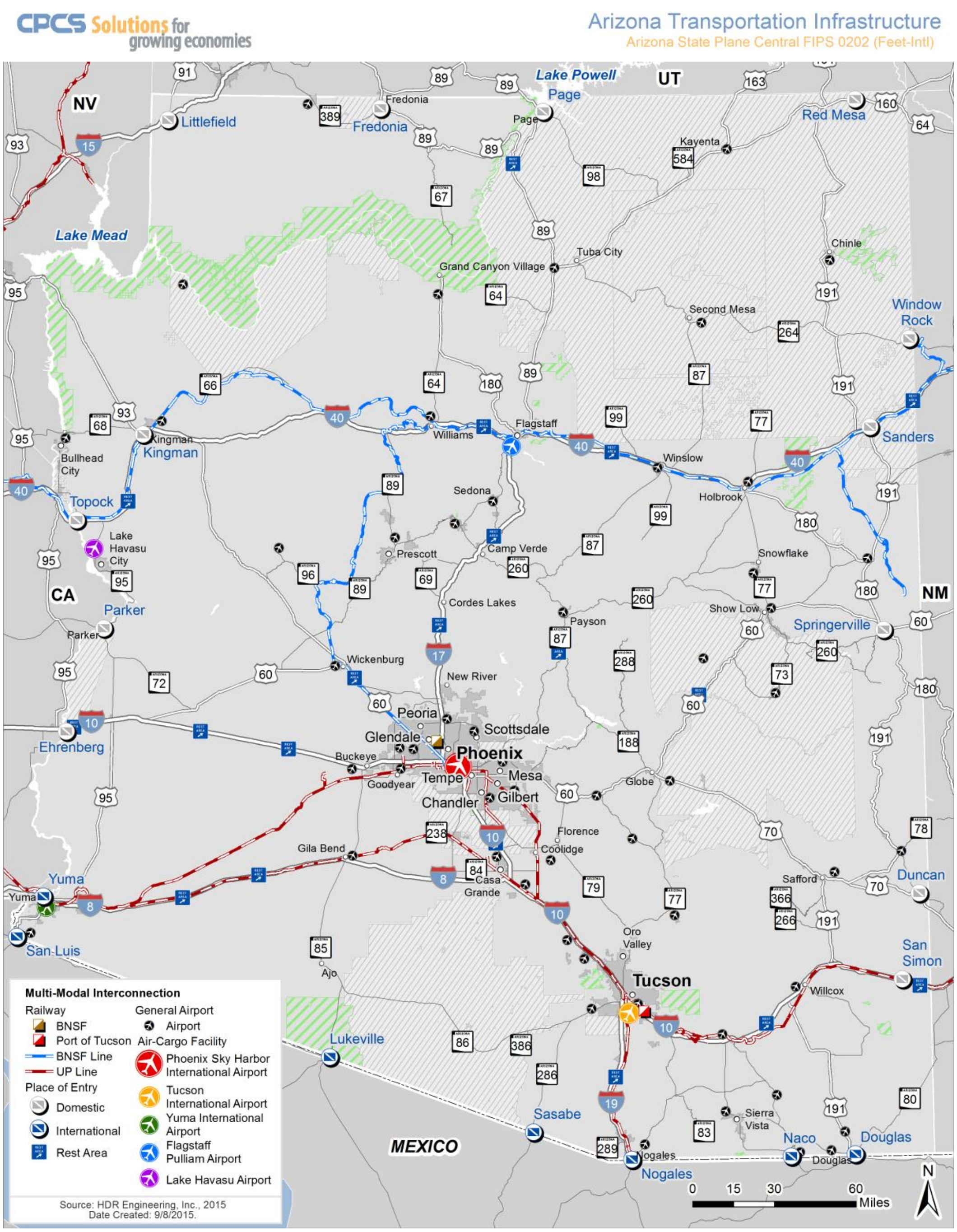
Contents

Executive Summary

Arizona's freight system consists of highways, railroads, air cargo terminals, pipeline, and land port of entry facilities. By volume, over three-quarters of the state's freight moves along the state's roadway network. Rail handles the largest share of the balance. Figure ES-1 provides a statewide overview of the multimodal freight transportation system.

Figure ES-1: Arizona Multimodal Freight Transportation System



The objective of Working Paper 2 is to provide an overview of the assets and facilities that comprise Arizona's freight transportation system, the freight flows moving over them, and their related performance.

Freight Highway System

There are over 66,000 highway miles in Arizona. The access-controlled Interstate highway system – comprising the core components of the State's highway freight network – makes up two percent, of total highways miles in the state, or 1,168 miles and is the most intensively utilized freight infrastructure in Arizona.

Freight movements on the Arizona highway system are characterized by their high share of through traffic – that is, neither originating or destined to Arizona – accounting for 39 percent of total flows by volume, and 64 percent of flows by value.

A significant component of this is traffic moving between the Ports of Los Angeles and Long Beach and inland markets, particularly along the I-40 and I-10 corridors. Figures ES-2 and ES-3 illustrate the shares of traffic by tonnage and value.

Figure ES-2: Annual Freight Flow by Tonnage

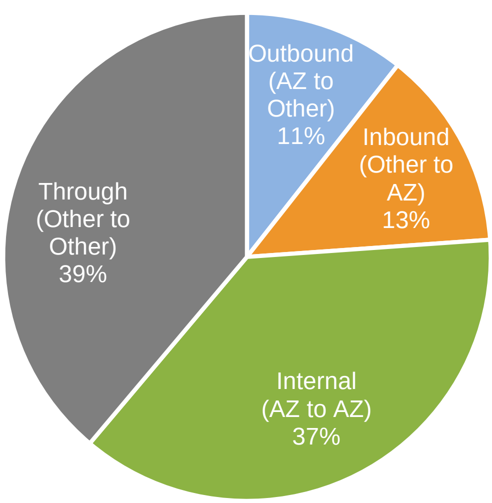
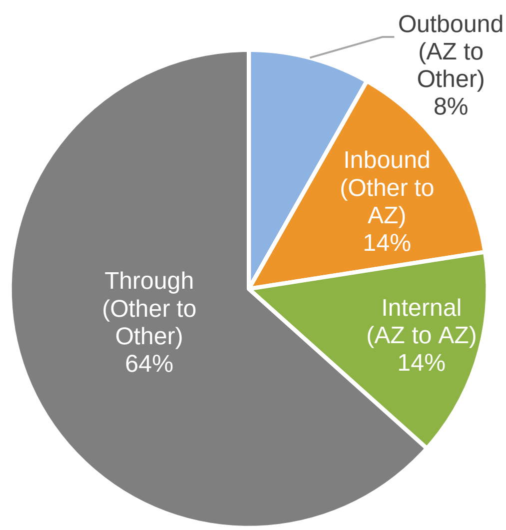


Figure ES-3: Annual Freight Flow by Value ($)



Source: Transearch (2013)

Congestion, which impacts transit time, reliability, and transportation costs, is most noticeable within the State's urban areas, including the Greater Phoenix and Tucson metropolitan areas, and to a lesser degree in the vicinity of Flagstaff, Prescott and Yuma. Delays at the U.S.-Mexico border crossing in Nogales are also common. Nevertheless, beyond these exceptions, highway level of service throughout the state can generally be described as high (LOS C or better).

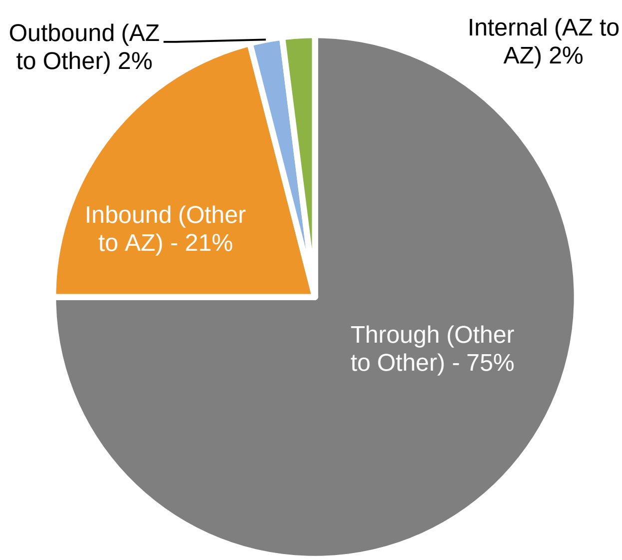
Freight Rail System

Arizona's freight rail system covers nearly 2,000 route miles and links Arizona industries and consumers with domestic and global trading partners.

Class I carriers BNSF Railway (BNSF) and Union Pacific Railroad (UPRR) operate 1,465 miles, or 73 percent of Arizona's rail network, and intermodal transfer facilities in Phoenix and Tucson. Short line carriers provide local service to rail-dependent industries like mining and provide connections to the Class I network.

Three-quarters of Arizona rail tonnage is moving through the state—mostly between the Ports of Los Angeles and Long Beach and major rail hubs in Chicago and Dallas over BNSF's Transcon and UPRR's Sunset Route.

Figure ES-4: Annual Freight Flow by Tonnage



Source: 2007 Transearch Data

Both the BNSF and UPRR are investing in their networks to remove any bottlenecks. At-grade crossings and the border crossing at Nogales were cited as other bottlenecks in the rail system.

Air Cargo System

Phoenix Sky Harbor International Airport (PHX) moves nearly 90 percent of all air cargo originating or terminating in Arizona. Tucson International Airport (TUS) handles nearly ten percent of the state's air cargo.

Integrators such as FedEx and UPS have increasingly expanded their market share in the movement of air cargo. In 2013, only 13 percent of air cargo in Arizona was carried on passenger aircraft.

While estimates suggest no new on-airport cargo infrastructure will be needed until 2031, highway access to air cargo facilities at PHX, especially the South Air Cargo complex, will need to be addressed.

Pipeline System

Two major pipelines – both operated by Kinder Morgan - supply Arizona with petroleum products. The "West Line" supplies products from the Los Angeles basin to Phoenix while the "East Line" originates in El Paso, Texas and connects to both Tucson and Phoenix. Liquid products are typically delivered to the end user by tanker truck from distribution terminals. Given the limited oil and gas production in the state, there are effectively no gathering pipelines in Arizona.

Most of the gas consumed in Arizona relies on truck deliveries which are made via one of the ten interstate gas pipelines. Natural gas is distributed to end users by pipeline.

Because pipelines are controlled by private businesses, information on their performance is difficult to ascertain.

Borders and International Freight Gateways

A greater percentage of volume/value arrives in Arizona by rail than other southern border states, but trucking still comprises the largest portion of trade between Arizona and Sonora.

Land-based border flows are heavily concentrated in two border crossings:

- Over 85 percent of exports and 88 percent imports from or to Arizona use the Nogales-Nogales border crossing.
- Over ten percent of exports and imports from or to Arizona uses the Douglas-Agua Prieta border crossing.

Recent improvements to Land Ports of Entry in the region have reduced congestion; however, stakeholders expect continued growth in border volumes, suggesting the need for continued planning and investment in border infrastructure.

Freight Clusters

Freight clusters are concentrations of freight-dependent businesses, often engaged in warehousing or industrial activities and frequently supported by nearby intermodal transfer terminals, airports, or pipeline terminals which facilitate the movement of goods between modes.

In Arizona, the greatest concentration of freight activity is located along the I-10 corridor in Phoenix and Tucson, and includes clusters located at Tolleson, Sky Harbor Airport, Chandler, and the Port of Tucson. Outside the two metropolitan areas, clusters are notably located in Casa Grande, Yuma City, Prescott Valley, Flagstaff, Lake Havasu City, Bullhead City, Sierra Vista and the border city of Nogales.

Arizona's freight clusters and generally well connected to the multimodal transportation system, although some experience congestion and delays.

Top Freight Mobility Constraints

While much of Arizona's multimodal transportation system currently supports efficient goods movement, top freight mobility constraints include, among other issues:

- Highway congestion in Arizona's urbanized areas and along Key Commerce Corridors creates significant freight bottlenecks.
- Arizona's freight rail network is lacking in north-south infrastructure, including limits to rail capacity, intermodal facilities, classification yards, and logistics centers.
- Local congestion affects highway movements of air cargo utilizing PHX.

Funding the necessary improvements to operate and maintain the state's transportation network is by far the greatest challenge faced by Arizona. $18.8 billion of funding is needed over the next 20 years to adequately operate and maintain the current transportation network in the state's Key Commerce Corridors.

Acronyms/Abbreviations

Acronyms / Abbreviations	Full Name
AAR	ASSOCIATION OF AMERICAN RAILROADS
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
ACA	ARIZONA COMMERCE AUTHORITY
ACC	ARIZONA CORPORATION COMMISSION
ADOT	ARIZONA DEPARTMENT OF TRANSPORTATION
ATRI	AMERICAN TRANSPORTATION RESEARCH INSTITUTE
BNSF	BURLINGTON NORTHERN SANTA FE
BTS	BUREAU OF TRANSPORTATION STATISTICS
CBP	CUSTOMS AND BRODER PROTECTION
CBRE	CB RICHARD ELLIS
CCTV	CLOSED-CIRCUIT TELEVISION
CFR	CODE OF FEDERAL REGULATIONS
CPCS	CPCS TRANSCOM, INC.
CRFC	CRITICAL RURAL FREIGHT CORRIDOR
DMS	DYNAMIC MESSAGE SIGN
EIA	ENERGY INFORMATION ADMINISTRATION
FAA	FEDERAL AVIATION ADMINISTRATION
FAF3	FREIGHT ANALYSIS FRAMEWORK VERSION 3
FAST	FREE AND SECURE TRADE
FEDEX	FEDERAL EXPRESS CORPORATION
FERC	FEDERAL ENERGY REGULATORY COMMISSION
FHWA	FEDERAL HIGHWAY ADMINISTRATION
FLG	FLAGSTAFF PULLIAM AIRPORT
FMS	FREEWAY MANAGEMENT SYSTEM
GAO	GOVERNMENT ACCOUNTABILITY OFFICE
HII	LAKE HAVASU CITY MUNICIPAL AIRPORT
HPMS	HIGHWAY PERFORMANCE MONITORING SYSTEM
I-8	INTERSTATE 8
I-10	INTERSTATE 10
I-15	INTERSTATE 15
I-17	INTERSTATE 17
I-19	INTERSTATE 19
I-40	INTERSTATE 40
IATA	INTERNATIONAL AIR TRANSPORT ASSOCIATION
ISTEA	INTERMODAL SURFACE TRANSPORTATION EFFICIENCY ACT
ITS	INTELLIGENT TRANSPORTATION SYSTEMS
LDC	LOCAL DISTRIBUTION COMPANIES

LOS	LEVEL OF SERVICE
LPOE	LAND PORT OF ENTRY
MAG	MARICOPA ASSOCIATION OF GOVERNMENTS
MAP-21	MOVING AHEAD FOR PROGRESS IN THE 21ST CENTURY ACT
MCF	MILLION CUBIC FEET
MMbbl/d	MILLION BARRELS (OF OIL) PER DAY
MP	MILE POST
MPD	MULTIMODAL PLANNING DIVISION
MPH	MILES PER HOUR
NAFTA	NORTH AMERICAN FREE TRADE AGREEMENT
NPMRDS	NATIONAL PERFORMANCE MANAGEMENT RESEARCH DATA SET
NYL	YUMA INTERNATIONAL AIRPORT
PAG	PIMA ASSOCIATION OF GOVERNMENTS
PFN	PRIMARY FREIGHT NETWORK
PHMSA	PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMINISTRATION
PHX	PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
PTC	POSITIVE TRAIN CONTROL
RCN	REGIONAL COMMUNITY NETWORK
RPZ	RUNWAY PROTECTION ZONE
SENTRI	SECURE ELECTRONIC NETWORK FOR TRAVELERS RAPID INSPECTION
SFPP	SANTA FE PACIFIC PIPELINES
SR	STATE ROUTE
TDM	TRAVEL DEMAND MODEL
TIM	TRAFFIC INCIDENT MANAGEMENT
TSA	TRANSPORTATION SECURITY ADMINISTRATION
TTTI	TRUCK TRAVEL TIME INDEX
TUS	TUCSON INTERNATIONAL AIRPORT
UPRR	UNION PACIFIC RAILROAD
UPS	UNITED PARCEL SERVICE
USDOT	U.S. DEPARTMENT OF TRANSPORTATION
USEIA	U.S. ENERGY INFORMATION ADMINISTRATION

1 Introduction

Key Messages

The Arizona State Freight Plan will define immediate and long-range investment priorities for the State's freight transportation system.

This Working Paper is the output of Phase 2 of 11 in the development of the Freight Plan. Its purpose is to provide an overview of the assets and facilities that comprise Arizona's freight transportation system, the freight flows moving over them, and their related performance.

This Working Paper is complemented by a geographic information system (GIS) database of the State's freight transportation system, and is provided separately.

1.1 Introduction: Economic Context

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

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

Effective freight planning and programming can help achieve these ends. Yet, fiscal realities are such that Arizona's Department of Transportation (ADOT) cannot address all transportation system needs and constraints. Rather, it must be strategic in defining and prioritizing its investments and system improvements.

To this end, ADOT's Multimodal Planning Division (MPD), is developing Arizona's State Freight Plan (Freight Plan, or Plan) which will provide strategic guidance to achieve its vision, goals and objectives.

Vision: Arizona's freight transportation system enhances economic competitiveness and quality growth through effective system performance and management.

Figure 1: Arizona State Freight Plan Goals and Objectives

Source: CPCS

1.2 Project Objectives

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

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

It should also inform broader transportation system planning in Arizona, including as related to future updates to the Long Range Transportation Plan (LRTP).

1.3 Purpose of this Working Paper

This working paper is the output of Phase 2 (of 11) in the development of the Arizona State Freight Plan. Its aim is to provide an overview of the assets and facilities that comprise Arizona's freight transportation system and their performance.

Specifically, Phase 2 addresses the following key questions:

Which facilities make up Arizona's freight transportation system and how well are these assets performing?

- How well are Arizona's highways/state roads, border crossings, railways, pipelines, and air cargo assets performing—in terms of capacity, speed, fluidity, and other metrics—in facilitating goods movement and economic output?
- What are the chief mobility constraints affecting the transportation flow of Arizona supply chains—including specific truck and rail bottlenecks?
- What is the nature and role of border gateway facilities at the U.S.-Mexico border and how do concentrations of freight activity at the border connect with supply chains throughout Arizona and surrounding states?
- What are the location and character of major clusters of warehousing, intermodal, and/or transload facilities statewide and how do those clusters interface with the multimodal freight network?
- Which multimodal corridors connect major warehousing, terminal, and border freight activity clusters and how well do these facilities serve freight-dependent industries including energy, mining, agriculture, timber, manufacturing, wholesale trade, and others?

1.4 Methodology

This working paper is organized to answer each of the key questions listed above. The findings were informed by a combination of literature reviews, data collection and analysis, and consultation with the operators and asset owners of Arizona's statewide multimodal freight system. Documents reviewed are footnoted throughout the working paper, as appropriate. A list of those consulted is provided in Appendix A (unless the stakeholder specifically requested that his or her input not be attributed).

This working paper is organized into chapters focusing on each mode (highway, railway, air cargo, and pipeline) with additional chapters dedicated to border crossing infrastructure and freight clusters. Each modal chapter describes the current system assets, utilization (flows), and performance (for example, how well each mode is functioning). Following the modal chapters, the working paper identifies major freight activity clusters and concludes with a chapter that ties all elements of the working paper together by examining how well the system serves major freight activity clusters and by identifying top freight mobility issues in Arizona.

This working paper is complemented by a geographic information system (GIS) database of Arizona's freight transportation system, which is provide separately, in electronic format.

1.5 Limitations

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

2 Freight Highway System

Key Messages

There are over 66,000 highway miles in Arizona. The access-controlled Interstate highway system – comprising the core components of the State's highway freight network – makes up two percent of total highway miles in the state, or 1,168 miles.

The share of freight moving over Arizona's highways that is through traffic – that is, neither originating in nor destined to Arizona – is 39 percent of total flows by volume, and 64 percent of flows by value. A significant component of this is traffic moving between the Ports of L.A./Long Beach and inland markets, particularly along the I-40 and I-10 corridors.

Congestion, which impacts transit time, reliability, and transportation costs, is most noticeable within the urban areas including the Greater Phoenix, Tucson, Prescott, Yuma and Flagstaff metropolitan areas. Delays at the U.S.-Mexico border crossing in Nogales are also common. Nevertheless, beyond these exceptions, highway level of service throughout the state can generally be described as high (LOS C or better).

2.1 Arizona's Freight Highway System Assets

Arizona's highway system consists of Interstate highways and federal, state, and local routes under the jurisdiction of the Federal Highway Administration (FHWA), ADOT, and local agencies, respectively. ADOT maintains the State Highway System excluding local roadways which are typically maintained by local agencies within their jurisdiction. Arizona's highway miles, by area type, is summarized in Figure 2.

Figure 2: Arizona Highway Miles by Functional Classification and Area Type

Functional Classification	Large Urban	Small Urban	Rural	Total (%)
Interstate	179	68	921	1,168 (2)
Other principal arterial and freeways	1,504	195	1,192	2,891 (4)
Minor arterial	1,692	266	1,173	3,131 (5)
Collector	1,418	681	5,973	8,072 (12)
Local	17,217	3,091	30,870	51,178 (77)
Total	**22,010**	**4,301**	**40,129**	**66,440 (100)**

Source: Arizona Department of Transportation (2013)

Arizona's major access-controlled Interstate corridors form the core components of the freight highway system. The Interstate highways are:

- **Interstate 10 (I-10)** - East-to-west corridor connecting California to Florida through Arizona's largest metropolitan areas, Phoenix and Tucson. I-10 is the southernmost transcontinental highway in the Interstate highway system.
- **Interstate 40 (I-40)** - East-to-west corridor connecting California to North Carolina through north-central Arizona, passing through Kingman and Flagstaff. I-40 is the third-longest Interstate highway in the United States, after Interstates 90 and 80.

I-10 is Key Arizona Link to Global Markets

Interstate Highway 10 is the key Interstate link between the Ports of L.A./Long Beach and Phoenix. Despite its importance, and the considerable growth of Southern California, the capacity of the Arizona section of I-10 corridor to Phoenix has remained largely unchanged since the 1970s – at four lanes (two in each direction)[1]. I-10 is also a critical link to markets east of Arizona.

[1] *Arizona's Key Commerce Corridors Final Report.* Arizona Department of Transportation, 2014.

- **Interstate 17 (I-17)** - North-to-south corridor located entirely within the state of Arizona, connecting Phoenix, at I-10, with its northern terminus in Flagstaff, at I-40. I-17 gains more than a mile in altitude between Phoenix (at 1,117 feet) and Flagstaff (at 7,000 feet).
- **Interstate 15 (I-15)** - North-to-south corridor located in the northwestern corner of Arizona, connecting Nevada and Utah and serving several Arizona communities. Because of the geography of the Grand Canyon, I-15 is not directly accessible from other routes within Arizona.
- **Interstate 19 (I-19)** - North-to-south corridor connecting the U.S.-Mexico port of entry at Nogales with Tucson. Like I-17, I-19 is an Interstate highway located entirely within Arizona.
- **Interstate 8 (I-8)** - East-to-west corridor connecting Casa Grande to San Diego, California. I-8 provides direct connection to Yuma and southern California.

In addition to the Interstates, several major highways link internal Arizona trade centers together and connect to out-of-state and international markets. These include:

- **US 93/US 60** - This corridor connects Phoenix and Las Vegas via Wickenburg and Kingman.
- **Route 85** - Arizona Route 85 provides a critical north-south connection between I-10 and I-8 from Buckeye to Gila Bend, effectively allowing some long-distance trucks utilizing the I-10 corridor to bypass the Phoenix metropolitan area.
- **US 89** - US Highway 89 between Flagstaff and Page facilitates freight movement in northern Arizona and provides an alternative link (to US 93/US 60/I-15) between Phoenix and destinations in Utah.
- **US 163/ US 160 -** This corridor connects northern Arizona with markets in southeastern Utah and western Colorado. Major commodities being transported along these routes include forestry, energy, manufacturing, and agricultural products.
- **US 70** - Is a critical east-west route in eastern Arizona, supporting, for example, movements of mining materials between Globe and Stafford.
- **Route 189**- Connecting I-19 to the US-Mexico Border at Nogales, SR 189 plays a major role as a freight corridor. Mexico is Arizona's largest international trading partner and Nogales is a fresh produce gateway into the U.S.

2.1.1 Highway Freight Corridor Designations

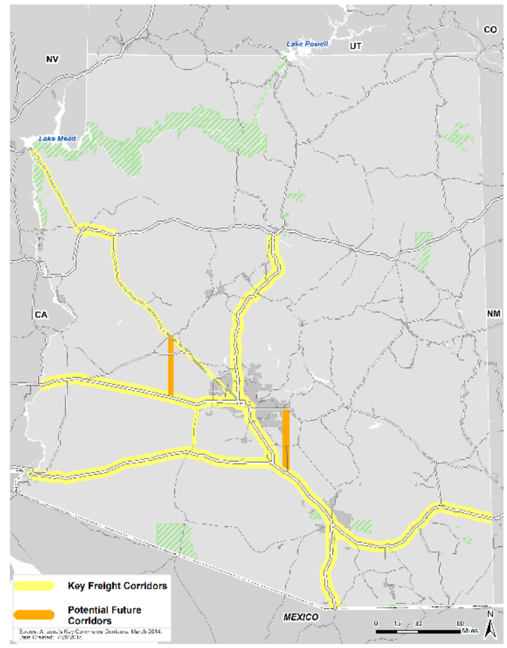
There is no single designation of Arizona's freight highway network. Freight network designations differ by federal or state classifications, as shown Figure 3 through Figure 7. Nevertheless, each of these classifications includes the Congressional High Priority

Corridors established by USDOT under the provisions of the Safe, Accountable, Flexible, and Efficient Transportation Equity Act.

Key Commerce Corridors

The Key Commerce Corridors[2] designation was developed by ADOT and key partners to highlight Arizona's connections to California, the Pacific Rim, Texas, the eastern U.S., northwestern Mexico and growing cities to the northwest and northeast and as part of a Key Commerce Corridors Plan to invest more than $20 Billion to "drive high-quality job creation." Building on this ADOT designation this working paper uses Key Commerce Corridors as the basis for reporting highway conditions (bottlenecks) and the location of multimodal features (rail corridors).

Figure 3: Arizona Key Commerce Corridors



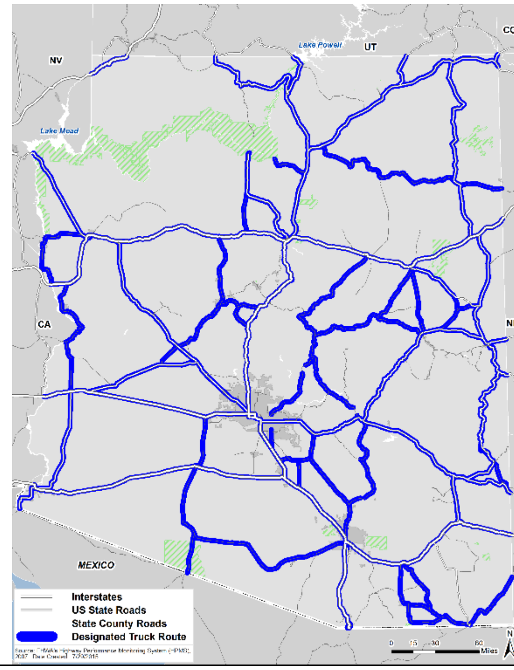
[2] *Key Commerce Corridors Final Report*. Arizona Department of Transportation, 2014.

Designated Truck Routes

Nationally designated truck routes include the Interstate system and non-Interstate routes, as defined by Federal regulations, on which commercial vehicles may legally operate.

A full-sized version of this map is provided in Appendix B, Figure 56.

Figure 4: Arizona Designated Truck Routes



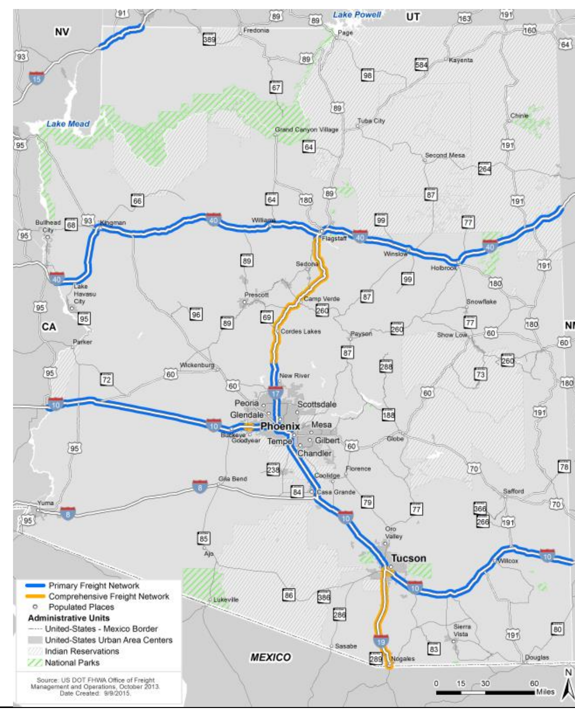
Draft Primary Freight Network

MAP-21 directed FHWA to establish a national freight network (draft) to assist states in strategically directing resources toward improved system performance for efficient movement of freight on the highway portion of the nation's freight transportation system.

The National Freight Network consists of three components: the Primary Freight Network (PFN), the portions of the Interstate System not designated as part of the highway PFN, and Critical Rural Freight Corridors (CRFCs), which are designated by the States.

A full-sized version of this map is provided in Appendix B, Figure 57.

Figure 5: Draft Primary Freight Network

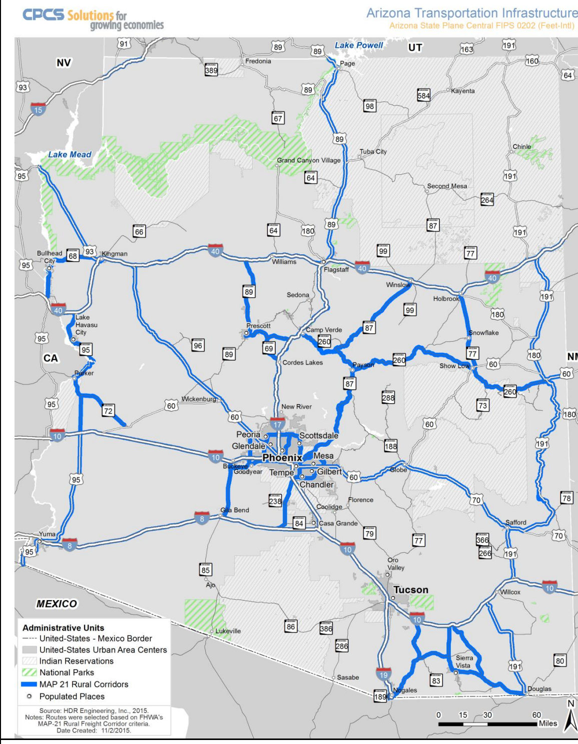


MAP-21 Critical Rural Freight Corridors

MAP-21 encourages each state to identify critical rural freight corridors to enhance freight mobility and to establish better connectivity and accessibility to the national freight network system. The FHWA criteria used to define these corridors address such items as: rural principal arterials having minimum truck traffic (25 percent AADT); access to energy resources; and connectivity to the Primary Freight Network.

A full-sized version of this map is provided in Appendix B, Figure 59.

Figure 6: MAP-21 Critical Rural Freight Corridors



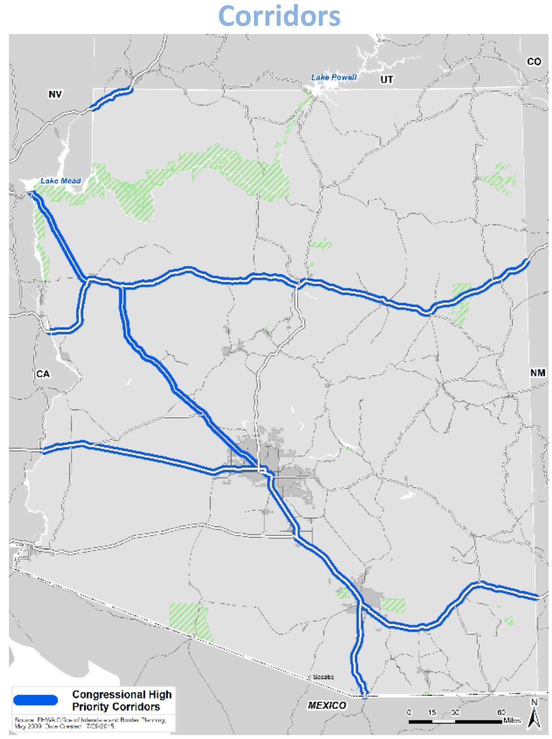
Congressional High-Priority Corridors

The Congressional High-Priority Corridors are established by USDOT under the provisions of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (Public Law 109-59). Within Arizona, four corridors are listed under this category.

The corridor numbers correspond to the statutory listing in Section 1105(c) of the Intermodal Surface Transportation Efficiency Act.

A full-sized version of this map is provided in Appendix B, Figure 60.

Figure 7: Congressional High-Priority Corridors



2.2 Highway Freight System Flows

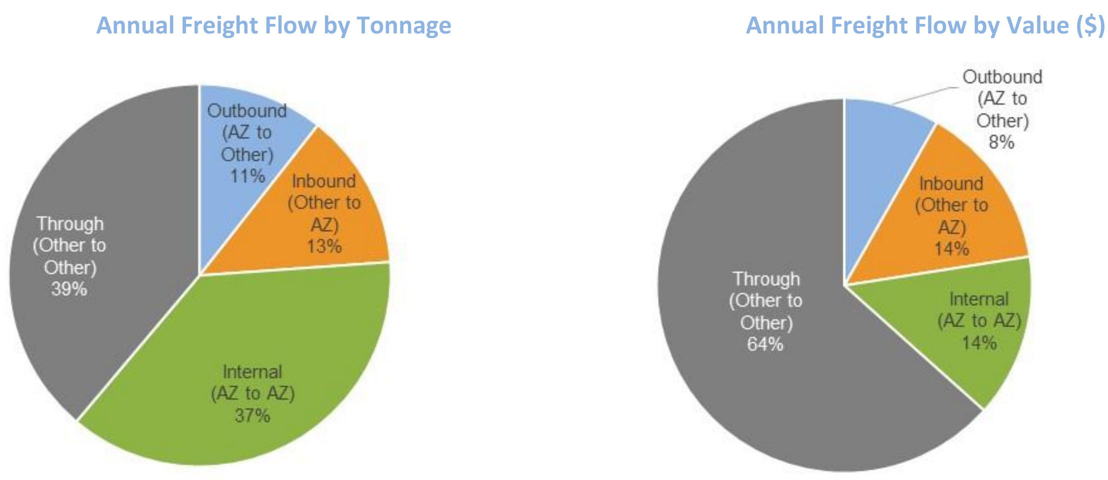
IHS Transearch data estimates freight flows to, from, within, and through Arizona.

Highway freight traffic moving through Arizona by truck represents he largest share of freight flows on Arizona's highways. This is particularly pronounced in terms of the value of goods moving through the State. freight on the state system.

Figure 8 shows the overall volume of freight goods moved, by tonnage and value. As shown in Figure 9, I-10 and I-40 carry the highest volume of freight on the state system.

Figure 8: Annual Freight Flow by Volume and Value

Category	Outbound (AZ to Other)	Inbound (Other to AZ)	Internal (AZ to AZ)	Through (Other to Other)	Total
Tonnage (000's)	25,600	32,000	89,900	93,700	241,200
Value (Million $)	39,977	69,522	68,495	307,979	485,973



Source: Transearch (2013)

Data collected by ADOT on truck volumes provide another snapshot of freight movement on the state's highway system, as shown in Figure 10. Generally Arizona's Interstates carry the highest percentage of trucks. For example, on some sections of I-10 and 1-40, more than 40 percent of the traffic flows are trucks. Rural highways connecting major freight generating facilities, like mines, show some of the highest truck percentages.

Figure 9: Map of Annual Freight Flow by Tonnage

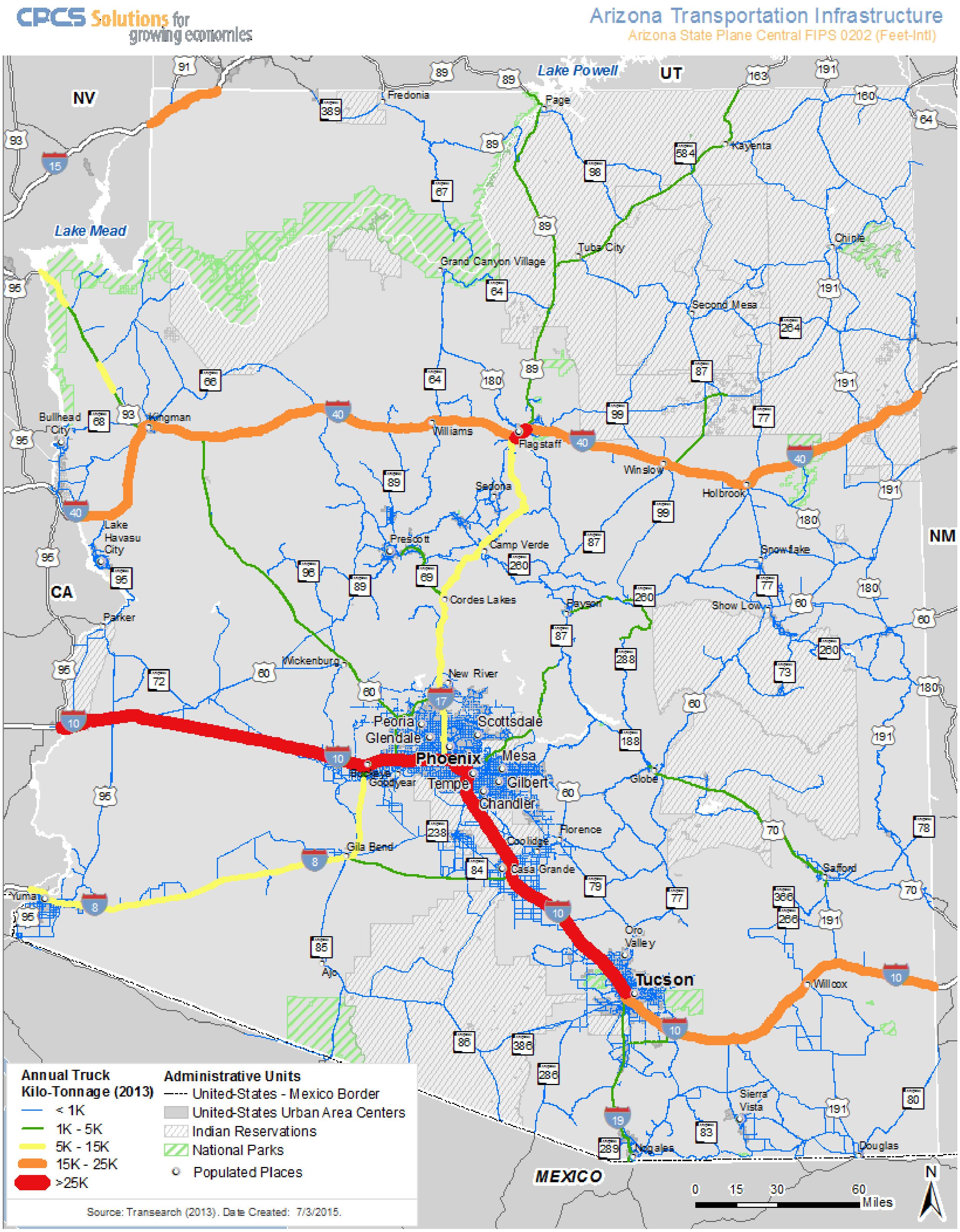
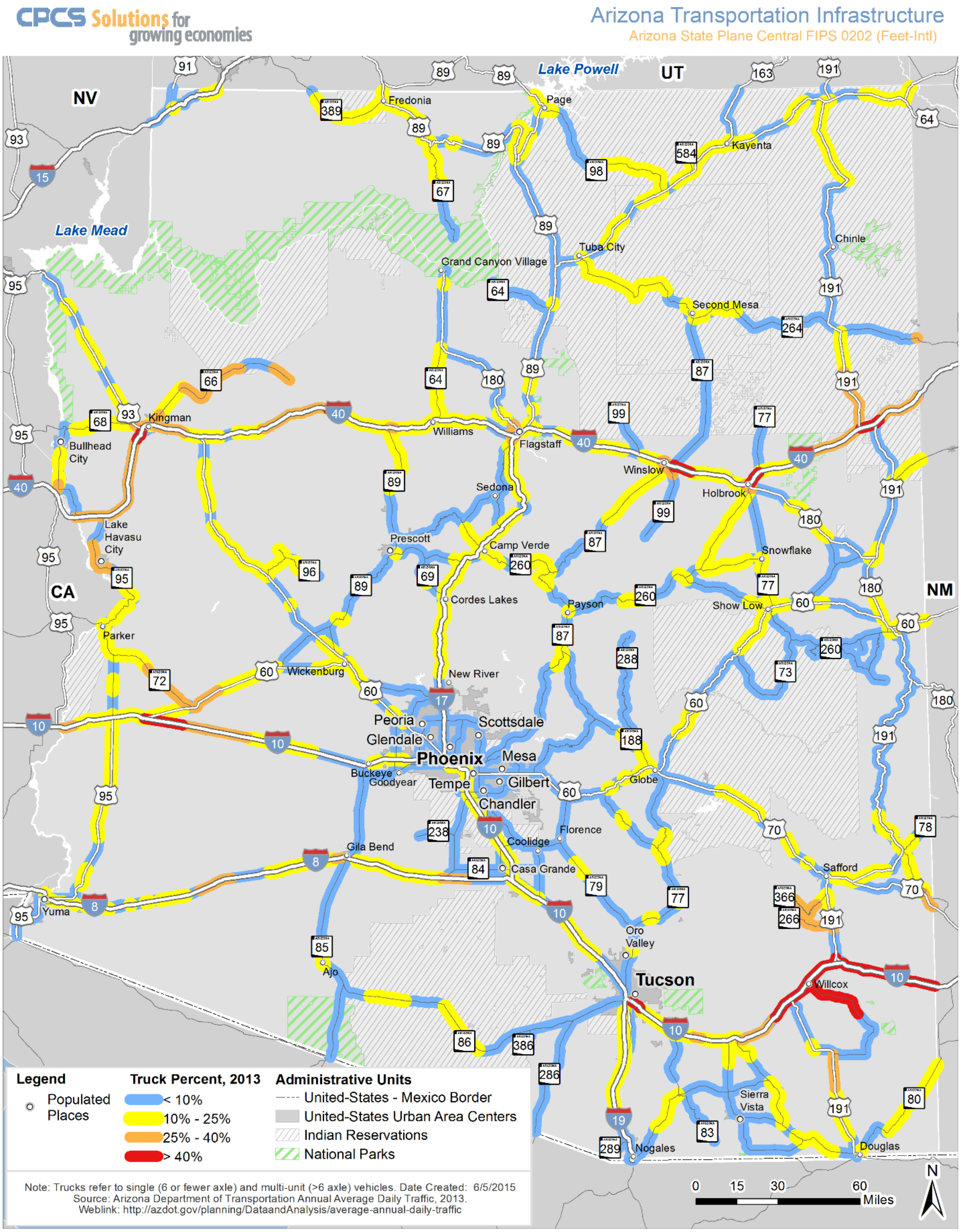


Figure 10: Truck Percentages



Source: Arizona Department of Transportation (2013)

2.3 Highway Freight System Performance

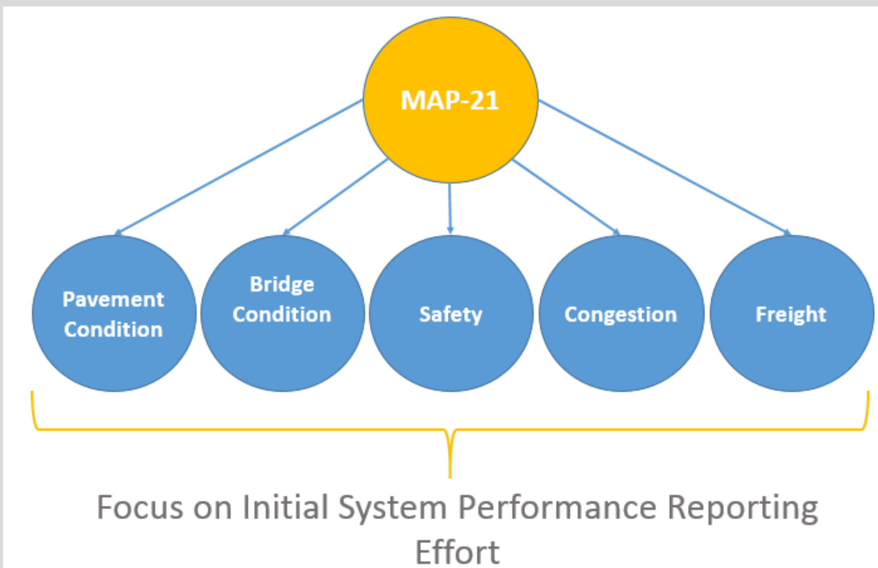
2.3.1 Highway Freight Performance Measures

Freight performance along roadway facilities in Arizona was evaluated using the performance measures noted in Figure 11.[3]

These performance parameters are broadly in line with those in ADOT's P2P Link and MAP-21 performance goal areas (see below).

P2P Link Performance Parameters for the State Highway System

The P2P Link process is focused on several key metrics for state highway system performance: pavement condition, bridge condition, safety, congestion, and freight, as summarized in the figure below. The initial system performance reporting is tied to MAP-21 performance goal areas.[4]



Source: Adapted from ADOT P2P Link, New Direction for Investment Decisions (2014)

[3] The performance of Arizona's freight transportation system will be further defined in Phase 5 in the development of the Arizona State Freight Plan. The performance parameters in this Phase 2 Working Paper are specific to assets and facilities.

[4] *ADOT P2P Link, presentation to 63rd Roads and Streets Conference*. Arizona Department of Transportation, 2014.

Figure 11: Highway Performance Measures

Highway Performance Measure	Significance
Infrastructure condition (bridge and pavement)	• Structurally or functionally deficient bridges affect freight flow and may add travel time when detours are required • Good pavement condition is the key to minimize freight operating costs and travel time
Number of lanes	• Provides a measure of available roadway capacity to accommodate existing volume and potential freight growth • Locations of recommended climbing lanes identify potential bottleneck locations
Capacity	• Recurring delays affect travel time and freight operating costs • Identifying congested bottleneck locations helps with freight route planning and with reducing delays
Speed	• Free freight flow improves reliability and trip planning • Lower speed is associated with additional travel time and higher operating costs
Fluidity	• Bottleneck locations result in delay (mostly attributable to recurring delay such as peak period congestion at high volume traffic locations)
Road closures	• Nonrecurring delays resulting from issues such as inclement weather, floods, crashes, and dust storms can cause major delays
Safety	• High crash locations cause major delays, and road closures can affect freight travel time and reliability, especially with time-sensitive and perishable deliveries
Reliability*	• Reliable, predictable travel times are especially important in a global economy, especially given the rise of just-in-time supply chains
Highway policy and regulatory issues	• Regulatory restrictions apply to trucks transporting hazardous materials • Truck size and weight affect the cost of transporting goods

The following provides a summary discussion of each of these highway performance measures. Appendix B provides supplemental details and maps.

2.3.2 Infrastructure Conditions

Nearly 80 percent of Arizona's Interstate facilities (79 percent) and the majority of the roadways (60 percent) that make up the state freight system are located in rural areas of the state. In urban areas much of the roadway infrastructure is relatively new, but identified infrastructure needs far outpace available funding.

The Arizona Long Range Transportation Plan estimated that over the next 25 years, $89 billion was needed for bringing the state transportation system to acceptable performance standards, with only $26 billion of expected revenue.[5]

Bridges

The Arizona's 2010 Long Range Transportation Plan estimated that Arizona's bridges required $1.5 billion for replacement, widening, strengthening, maintenance and operations over the 25 year planning horizon.[6] A subsequent study completed in 2014 on Key Commerce Corridors identified 151 bridges (70 on Key Commerce Corridors, 41 on other corridors and 40 others throughout the state) for reconstruction at a cost of $400 million.[7] Figure 61 in Appendix B shows bridge conditions for the state highway system.

Pavement Condition

Pavement condition is an important indicator of the state's highway infrastructure conditions. For 2014 (the latest year for which comprehensive information is available), 1,700 directional miles (20 percent) of 8,700 miles of ADOT-owned roadways are in poor condition, with an additional 2,400 miles (28 percent) in fair condition. The map in Appendix B, Figure 62 provides a statewide overview of pavement conditions.

Number of Lanes

Most rural Interstates in Arizona have two lanes in each direction. I-10 between Phoenix and Tucson has six through lanes – three per direction – with the exception of the segment through the Gila River Indian Community (immediately south of the Phoenix metropolitan area), where there are two lanes in each direction. Other state facilities in rural areas typically have two lanes—one per direction. A number of highways in the Greater Phoenix area have more than six lanes. The figure below shows the through lanes on the state

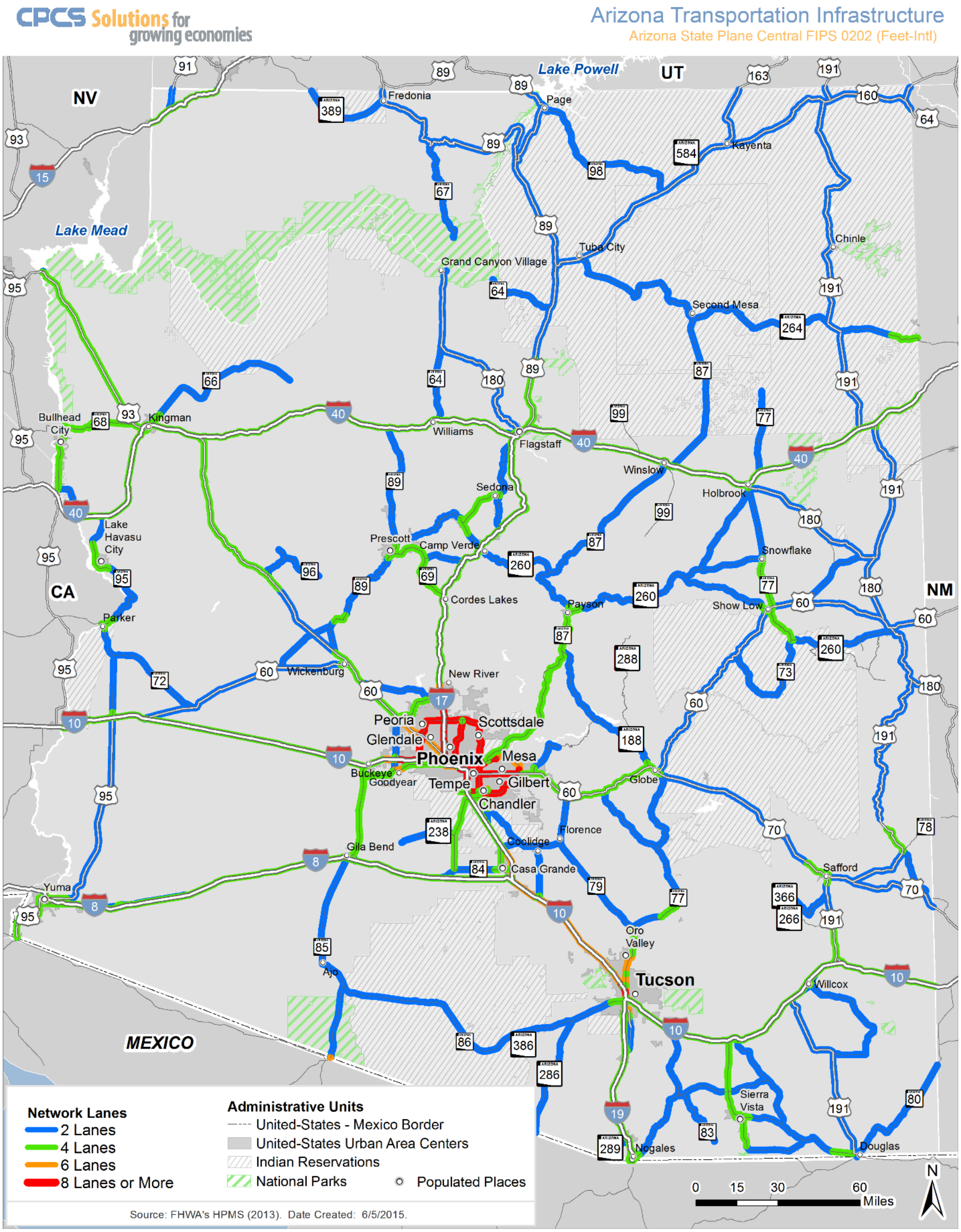
[5] *What Moves You Arizona Long-Range Transportation Plan 2010-2035*.

[6] Ibid.

[7] *Key Commerce Corridors Final Report*. Arizona Department of Transportation, 2014.

highway system. Maps showing truck restrictions at low bridge clearance locations and prioritized climbing lanes are provided in Appendix B, Figure 63 and Figure 64, respectively.

Figure 12: Arizona Network Through Lanes



2.3.3 Capacity

To measure and describe the operations of a road network, traffic engineers and planners commonly use a grading system called Level of Service (LOS). The LOS grading system qualitatively categorizes traffic conditions associated with varying traffic flows. These levels range from LOS A, which indicates free-flow traffic conditions with little or no delay experienced by motorists, to LOS F, which describes congested conditions where traffic flows exceed design capacity, resulting in long queues and delays. Figure 13 displays the LOS scale and includes a description of the types of roadway conditions associated with that particular level of service. LOS applies to all traffic on a roadway and does not distinguish between different freight and passenger vehicle types.[8]

Figure 13: Description of Level of Service

Level of Service	Technical Description
LOS A	**Minimal congestion** - Free flow conditions with minimal delay
LOS B	**Minimal congestion** - Stable flow conditions with occasional delays
LOS C	**Low congestions** - Stable conditions with periodic delays
LOS D	**Moderate congestion** - Restricted flow conditions with regular delays due to congestion
LOS E	**High congestions** - Constrained flow conditions with extended delays due to high congestion
LOS F	**Very high congestion** - Forced flow conditions with excessive delays due to excessive congestion.

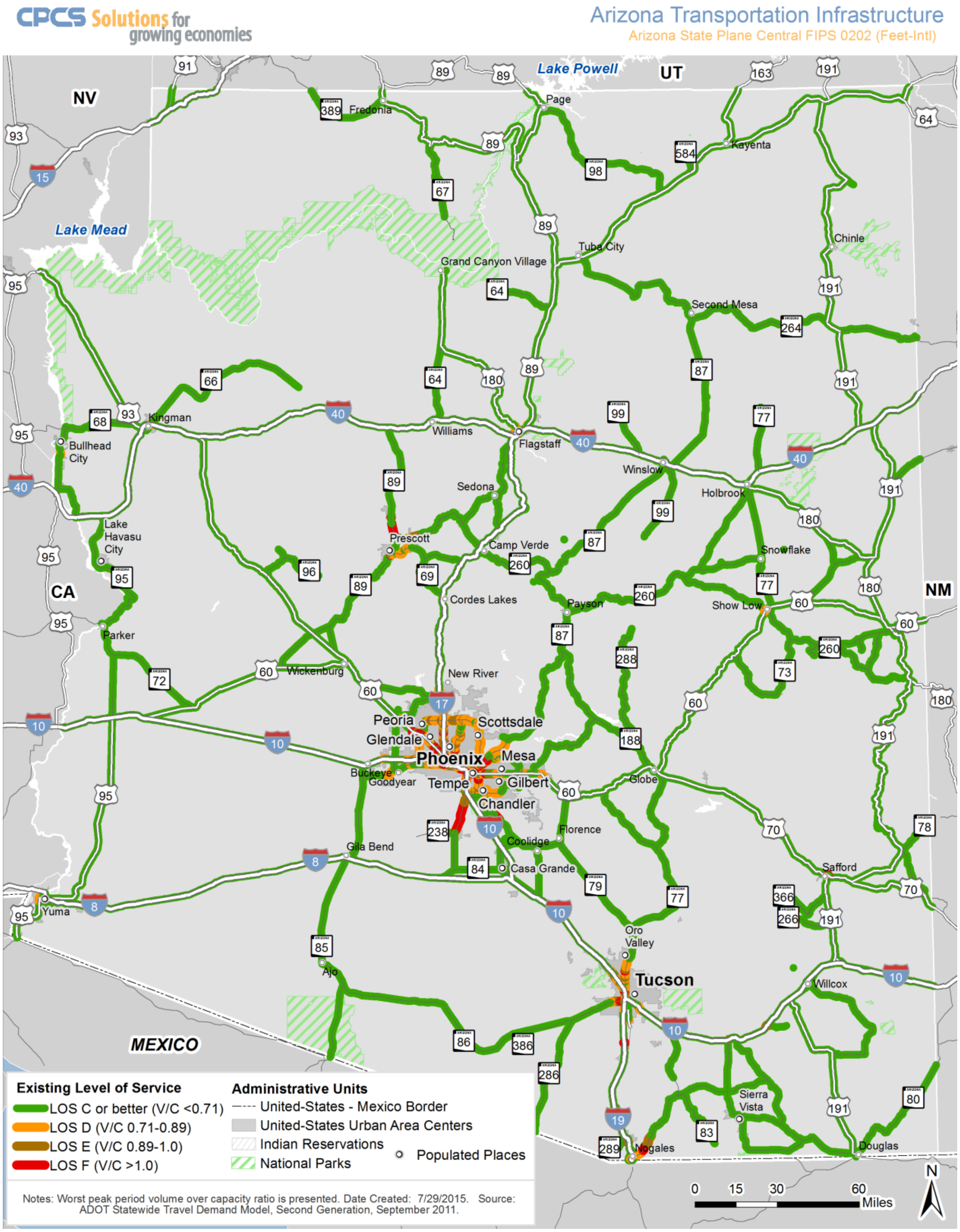
Source: HDR Engineering Inc., 2015

The Arizona Statewide Travel Demand Model (AZTDM) was used to identify peak period congestion along major state facilities and to develop a volume-over-capacity ratio to present LOS. [9]

As shown in Figure 14, congestion is noticeable within the urban areas including the Greater Phoenix, Tucson, Prescott, Flagstaff metropolitan and Yuma areas. Delays near the U.S.-Mexico border crossing in Nogales are also identified in the AZTDM results. Nevertheless, beyond these exceptions, highway level of service throughout the state can generally be described as high (LOS C or better).

[8] While useful to monitor the overall performance of the transportation system, and for planning future transportation facilities; level of service alone is not indicative of performance as it does not reflect non-recurring, peak period, or other delays which are not represented in overall service measure.
[9] Arizona Statewide Travel Demand Model (AZTDM), 2nd Generation.

Figure 14: Existing Level of Service



Source: Arizona Department of Transportation (2011)

2.3.4 Speed

In Arizona, outside of the urban areas, Interstate facilities including I-10, I-17, I-15, I-8, and I-40 have a posted speed limit of 75 miles per hour (mph). In urban areas, the posted speed limits are lower. Along state and U.S. routes, posted speed limits are typically 65 mph. It is important to note that truck operating speeds are typically lower as a result of steep grades, sight distances, and nighttime visibility, among other factors. A map of posted speed limits in Arizona is provided in Appendix B, Figure 65.

2.3.5 Fluidity

In 2009, the American Transportation Research Institute (ATRI) conducted a study in cooperation with FHWA's Office of Freight Management and Operations that indicates that three Arizona interchanges ranked among the 100 worst in the nation in terms of the fluidity of truck freight flows (see Figure 15).[10]

Figure 15: Arizona Interchanges Among FHWA's 100 Worst Performing

"The Stack", I-10 and I-17 interchange in Phoenix (ranked 60 in 2014)

I-10 and I-19 interchange in Tucson (no longer in top 100, in 2009 ranked 78)

"The Mini-Stack", I-10, SR 51 and SR 202L interchange in Phoenix (no longer in top 100, in 2009 ranked 86)

The performance measure for recurring delay is the Directional Truck Travel Time Index (TTTI). TTTI is the ratio of average peak period travel time to free-flow travel time. TTTI reflects the extra time spent in traffic during peak times due to recurring delay, which refers to expected or normal delay due to roadway capacity constraints or traffic control devices, given traffic patterns. The TTTI for Arizona was developed using the National Performance Management Research Data Set (NPMRDS).

Figure 15 provides summary information on some of the major bottleneck locations outside the Phoenix metropolitan area along Arizona's Key Commerce Corridors. Figure 16 uses data from ATRI to identify the bottlenecks occurring in Arizona during the past year.

[10] Federal Highway Administration, 2009.

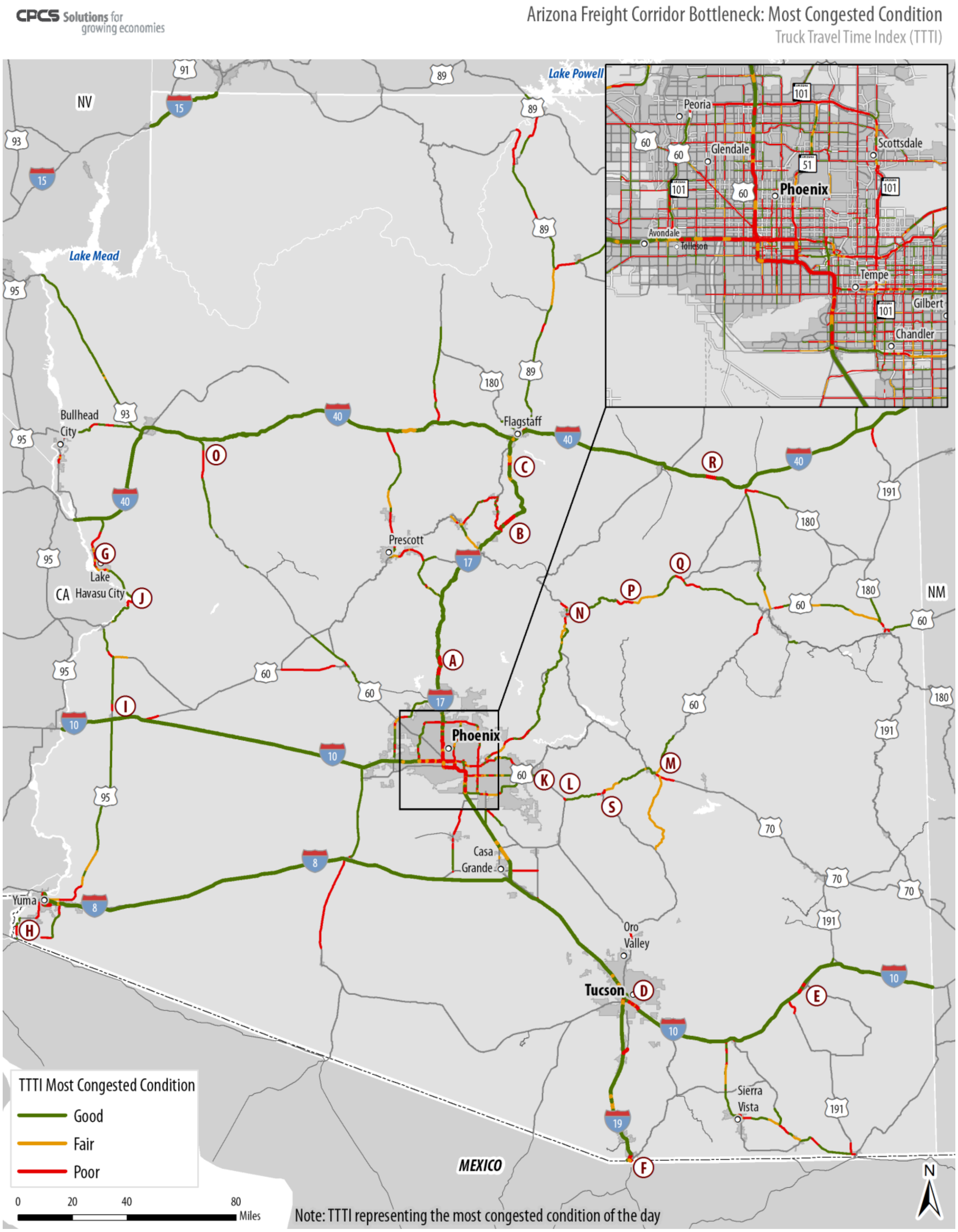
Figure 16: Major Truck Bottleneck Locations along Arizona's Key Commerce Corridors

Map key	Highway	Segment Location	Direction	Major Contributing Factor				
				Congestion	Steep grades	Curves	Border crossings	Truck/local activity
A	I-17	Mile post 232 to 242 (within Black Canyon City)	Northbound		pm			
B	I-17	Mile post 298 to 306 (AZ 179 to Stonaman Lake Rd)	South		pm			
C	I-17	Mile post 329 to 331 (nine miles south of Flagstaff)	Northbound		mid			
D	I-10	At I-19 traffic interchange in Tucson	Both	am pm				
E	I-10	Within Wilcox area (milepost 36 to 40)	Both					am
F	I-19	Nogales Port of Entry	Both				mid	
G	SR 95	Within Lake Havasu City	Both	am pm				
H	US 95	San Luis Port of Entry	Both				am pm	
I	US 95	North of I-10	Both					am
J	US 95	Parker Dam area	Both			pm		
K	US 60	Within Gold Canon area (milepost 200 to 208)	Both					am mid
L	US 60	At SR 79 junction	Both					am pm
M	US 70	East of Globe (milepost 252 to 259)	Both					am
N	SR 87	within Payson at SR 260 (milepost 249 to 258)	Both	am pm				
O	US 93	South of I-40	Both	am				
P	SR 260	mileposts 274 to 282 (Christopher Creek area)	Both			mid		
Q	SR 260	mileposts 303 to 313 (Heber area)	Both			am		
R	I-40	East of Winslow area (mileposts 269 to 274)	Both					pm
S S	US 60	At SR 177 (mileposts 224 to 228)	Both					am mid

Source: CPCS/HDR (2015)

Roadway geometry is a major contributing factor of truck bottlenecks in addition to congestion. Roadway geometry includes curves and steep grades which impact truck speed. Another cause of truck bottlenecks is border crossings, which are discussed in more detail in Section 6 of this report. Figure 17 shows that truck bottlenecks occur in locations within the congested metropolitan areas as well as in rural areas of the state. The letters in this figure correspond to the segments identified in the previous figure. Additional maps showing bottlenecks in morning, mid-day and evening peaks are provided in Appendix B, Figure 66, Figure 67, and Figure 68, respectively.

Figure 17: Map of the Major Truck Bottleneck Locations throughout Arizona



2.3.6 Road Closures

Bottlenecks cause recurring, predictable congestion in selected locations, while the temporary loss of capacity, or **nonrecurring congestion**, is widespread and less predictable. Sources of nonrecurring delay include incidents, weather, work zones, and other disruptions.

ADOT's Highway Condition Reporting System dataset was used to identify the number of incidents that require state facilities to be partially or fully closed. From 2013 through May 2015, the Highway Condition Reporting System recorded over 32,000 events. The reasons reported for closures were primarily related to traffic crashes, weather and environmental conditions, construction, maintenance, and obstruction hazards (fire, mudslide, rock fall, flood, fallen objects). Several weather-related, nonrecurring event types are worth noting, as the impact to freight flow in the state can be significant.

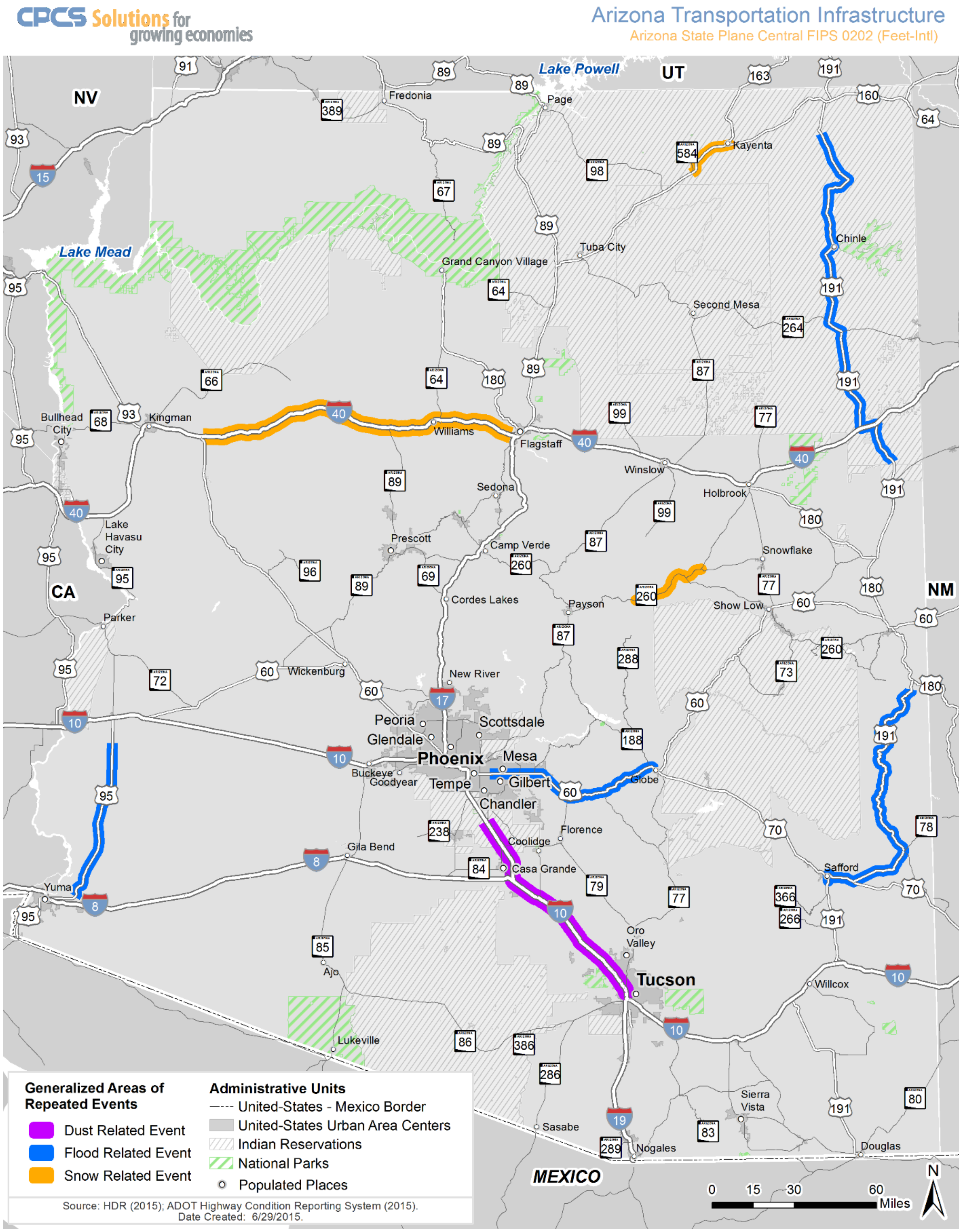
Snow-related closures and activity is limited to higher elevation highways in the northern part of the state. The major freight routes routinely affected by snow-related closures are largely limited to the Colorado Plateau (primarily areas of I-40 and US 60) and in the eastern part of the state, on and above the Mogollon Rim (SR 260). During these incidents, weather-related crashes may occur, and delays and closures can last hours for any single event. Generalized locations of these non-recurring events and the nature of the event are shown in Figure 18.

Dust storms account for a small percentage of crashes on highways in Arizona. However, they can come on suddenly and are difficult to forecast. Because the storms may block visibility they have the potential to be deadly and disruptive, involving large numbers of vehicles and impeding travel for hours. While dust storms can occur throughout the state, the stretch of I-10 between Tucson and Phoenix has the highest incidence of closures, with the area of Picacho Peak (milepost 213-214) reporting the highest incidence along I-10.

Flooding related events are common, particularly in the eastern parts of the State. The greatest number of events was recorded on US Highway 191, US Highway 95, and US Highway 60.

Other Events. In addition, a landslide was reported along US 89 near Page which caused significant damage and roadway closure for a prolonged period. Also with the analysis period, mudslides were reported along SR 89 (south of Prescott), US 70 (east of Globe), and I-10 (west of SR 90), SR 260 (east of Payson) and a forest fire was reported on SR 260 near Payson (milepost 275).

Figure 18: Generalized Locations of Non-Recurring Delays



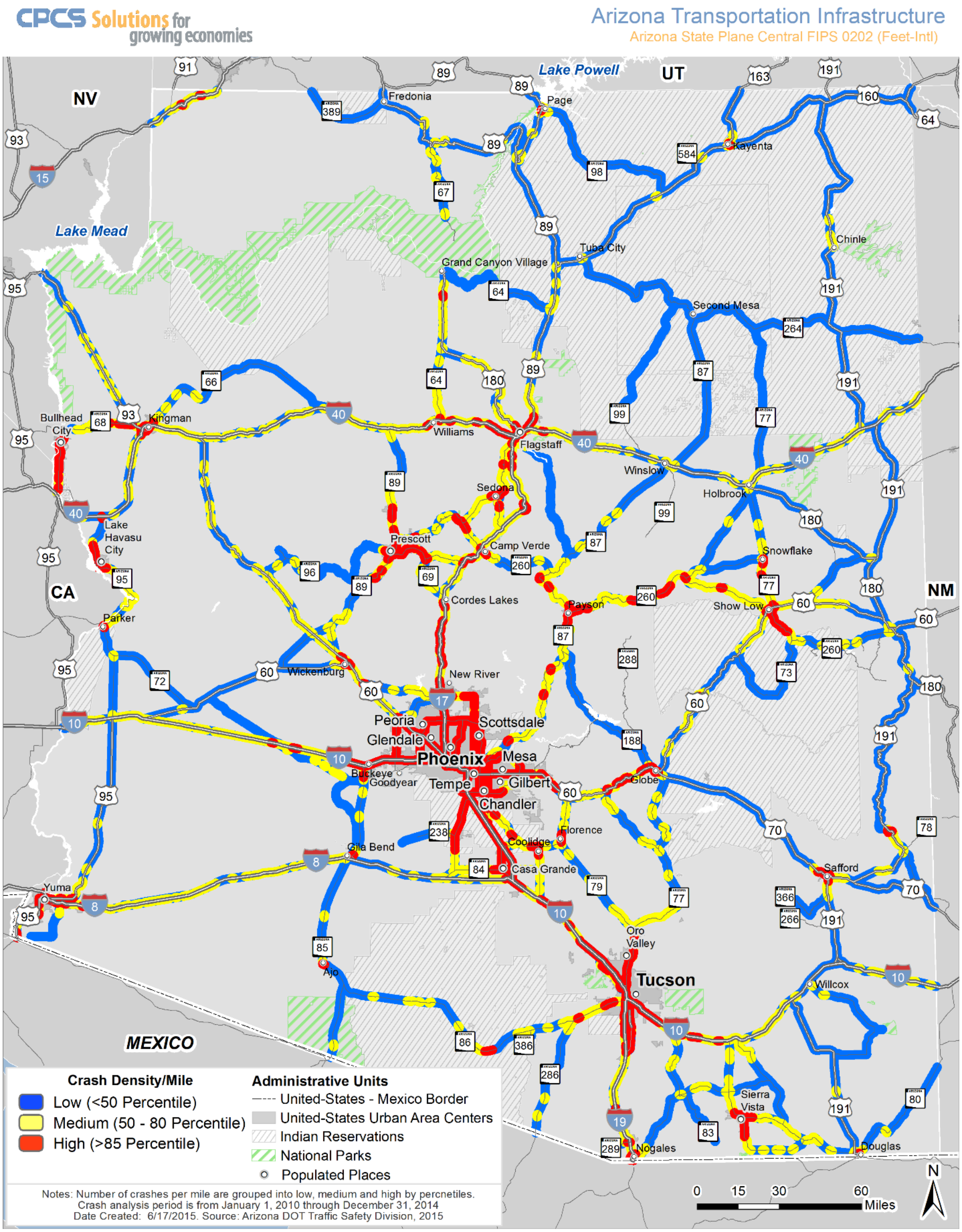
2.3.7 Safety

The Arizona Strategic Highway Safety Plan indicated that approximately 13 percent of all fatalities attributable to traffic crashes are related to heavy vehicles.[11] Approximately nine percent of serious injuries are also related to heavy vehicles[12]. Heavy vehicle-involved fatalities and serious injuries are most often the result of multiple-vehicle rear-end collisions. Figure 19 shows the truck-involved crashes for the five year period beginning in 2010. Not surprisingly, truck crash density is greatest in those areas where roadway volumes are highest.

[11] *Arizona Strategic Highway Safety Plan.* Arizona Department of Transportation, 2014.

[12] Heavy vehicles are vehicles that are either over 10,000 pounds in weight, contain nine or more seats, or carry hazardous material.

Figure 19: Truck-involved Crash Density



2.3.8 Highway Policy and Regulatory Issues

Arizona, like other states, is regulated by state statutes and federal regulations. All highway and transit projects in the state funded under Title 23 and the Federal Transit Act must be included in a federally approved Statewide Transportation Improvement Program. Projects in the Statewide Transportation Improvement Program must be consistent with the statewide long-range transportation plan and metropolitan transportation improvement programs.

Truck Size and Weight Policy

Truck length and weight limits were imposed by Congress in 1982 to potentially improve highway safety and reduce pavement impacts and costs associated with these roadway movements.

Current federal regulation specifies that the maximum load for the National Network (which includes the Interstate system and other designated highways) is 80,000 pounds gross vehicle weight. Off the Interstate highway system, states may set their own commercial vehicle weight standards. Arizona maintains an 80,000 pound weight limit throughout the state. Trucks traveling over the legal limit may be eligible for Oversize/overweight permits (e.g., Class C Permits) obtained through ADOT. Consultations with freight carriers reported that this process is burdensome.[13]

Hazardous Material

Arizona has yet to formalize a process for designating hazardous materials routes throughout the state. There are several routes that are restricted from carrying hazardous materials within the Phoenix metropolitan area, including: I-10 Deck Park Tunnel (between 7th Street and 7th Avenue), Salt River Bridge along SR 202L at SR 101L, and U.S. Route 60 at SR 101L.

ADOT has other locations where suggested hazardous materials routes are signed, such as at the I-8 and I-10 split south of Casa Grande (I-8 to SR 85 is a recommended route around the I-10 Deck Park Tunnel). However, these are not officially “designated” as hazardous materials routes.

[13] USDOT has prepared a study examining the impacts of increasing current federal truck size and weight limits addressing differences in safety risks, infrastructure impacts, freight diversion due to these alternative configurations. While currently under peer review, USDOT stated when releasing the report, “The Department [USDOT] finds that the current data limitations are so profound that no changes in the relevant laws and regulations should be considered until these data limitations are overcome.”

2.3.9 Other Performance Measures

Design

ADOT's roadway design is guided by the agency's Roadway Design Guidelines Manual (2012 Edition). The purpose of standardized design is to provide the most desirable design parameters consistent with safety, service, environment, and cost effectiveness and to apply these parameters with sound engineering judgment. The goal is to provide a highway which increases transportation service and safety in a manner that is consistent with its setting and which is compatible with the community and State values and plans.

Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS) are the application of advanced sensor, computer, electronics and communication technologies and management strategies to improve the overall safety and efficiency of the transportation system.

ADOT operates a Freeway Management System (FMS), which currently covers approximately 150 miles of the Phoenix metropolitan area freeway system. The FMS supports traffic management, incident management and response, special event traffic management, and traveler information. Components of ADOT's FMS include vehicle detection, closed-circuit television (CCTV) camera surveillance, dynamic message signs (DMS), ramp meters, and a fiber-optic/wireless communications network. The FMS fiber-optic communications paths also provide connectivity to local agency traffic management systems via the Regional Community Network (RCN).

ADOT has been enhancing the FMS to better support traveler information (including additional travel time display signs on freeways) and reduce congestion due to traffic incidents through better regional coordination with the Traffic Incident Management (TIM) Coalition.

3 Freight Rail System

Key Messages

Arizona's freight rail system covers nearly 2,000 route miles and links Arizona industries and consumers with domestic and global trading partners.

Class I carriers BNSF Railway (BNSF) and Union Pacific Railroad (UPRR) operate 1,465 miles, or 73 percent of Arizona's rail network, and intermodal transfer facilities in Phoenix and Tucson. Short line carriers provide local service to rail-dependent industries like mining and provide connections to the Class I network.

Three-quarters of Arizona rail tonnage is moving through the state—mostly between the Ports of Los Angeles and Long Beach and major rail hubs in Chicago and Dallas over BNSF's Transcon and UPRR's Sunset Route.

Both the BNSF and UPRR are investing in their networks to remove any bottlenecks. At-grade crossings and the border crossing at Nogales were cited as other bottlenecks in the rail system.

3.1 Arizona's Freight Rail System Assets

Arizona's freight rail system supports a combination of global and long-distance domestic trade and movement of key products made, grown, or mined in Arizona. This section presents Arizona's freight rail system assets, key corridors and facilities, characteristics, and performance measures. This inventory is primarily based on freight rail documents recently completed by ADOT and various regional agencies, including the 2011 Arizona State Rail Plan. More recent information on current railroad assets was collected and used to supplement available sources, including consultations with many of Arizona's freight railroads.

3.1.1 Overview of Freight Rail System Characteristics

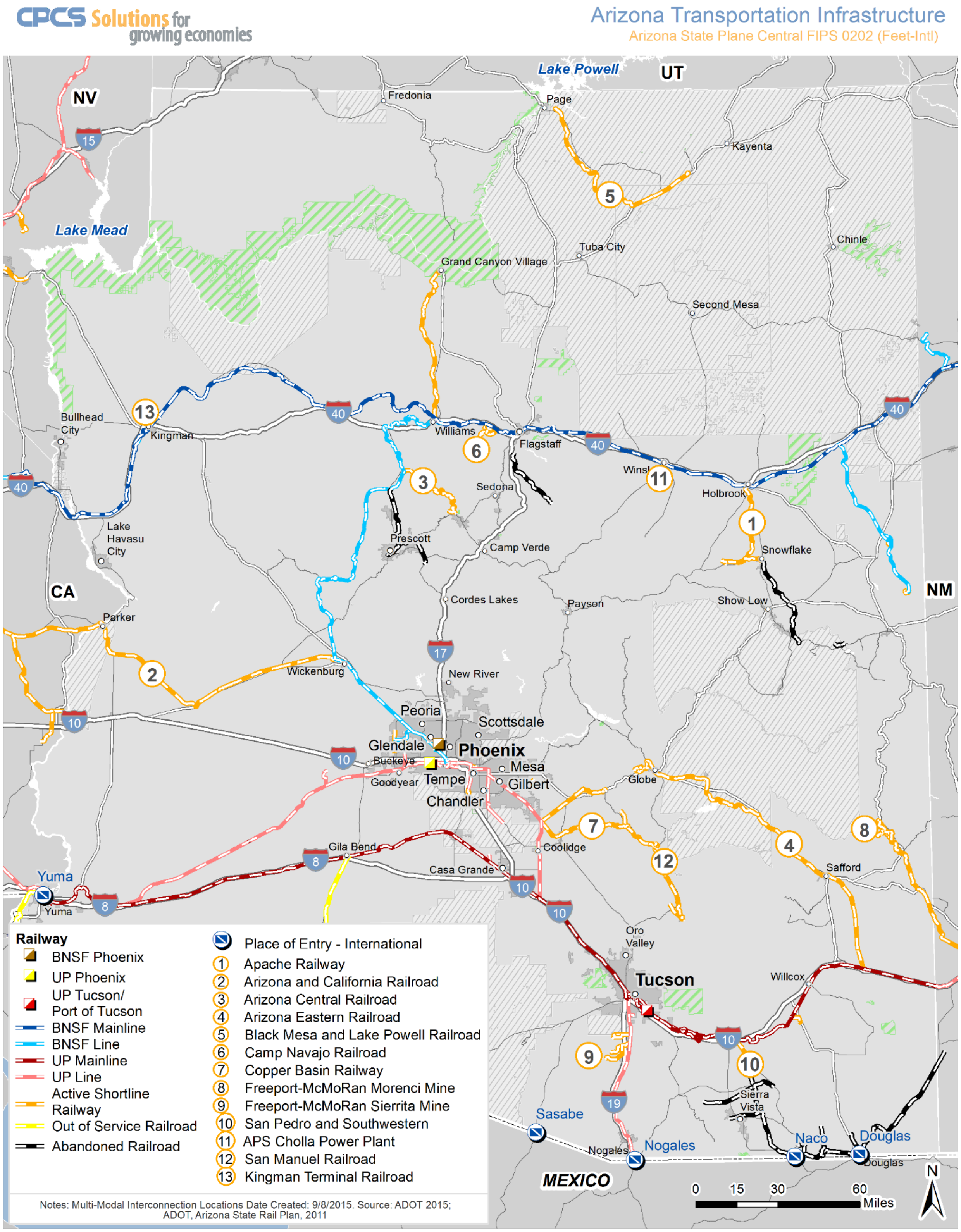
As documented in the 2011 Arizona State Rail Plan prepared by ADOT, the state's freight rail system consists of two Class I railroads and 13 short line (or Class III)[14] and terminal railroads. Arizona's freight rail network includes almost 2,000 route miles of tracks owned and operated by these railroads. Figure 20 shows Arizona's Class I railroads and the locations of the state's active short Line railroads. Figure 21 documents key features of each railroad, including route miles.

Together, Arizona's two Class I railroads BNSF Railway and UPRR operate approximately 73 percent of Arizona's freight rail system, encompassing 1,465 miles of combined service in Arizona.

Arizona's active short line railroads operate 529 miles of track equivalent to approximately 23 percent of the route miles of the state's overall freight rail system. Several key intermodal and bulk terminals provide railroad access to Arizona shippers and consumers.

[14] Short line or Class III railroads operate within relatively short distances (under 350 route miles) and with low annual operating revenues (less than $40 million).

Figure 20: Arizona's Class I Railroads,Branch Lines, and Short Line Railroads



Source: HDR Engineering, Inc. (2015)

Figure 21: Arizona Freight Railroad Summary of Track Miles Owned

Class I Railroads		
Railroad	**Route Miles (Tracks)**	**Percentage of State Route Miles**
BNSF Railway	690	34.1%
Union Pacific Railroad	775	38.3%
Subtotal Class I Railroads	**1,465**	**72.3%**
Short Line (Active) Railroads		
Railroad	**Route Miles (Tracks)**	**Percentage of State Route Miles**
Apache Railway	38	1.9%
Arizona & California Railroad	106	5.2%
Arizona Central Railroad	39	1.9%
Arizona Eastern Railroad	135	6.7%
Black Mesa & Lake Powell Railroad	78	3.8%
Camp Navajo Railroad	38	1.9%
Copper Basin Railway	55	2.7%
San Manuel Arizona Railroad	29	1.4%
Freeport-McMoRan Morenci Mine	15	0.7%
Freeport-McMoRan Sierrita Mine	2	0.1%
San Pedro & Southwestern	7	0.3%
APS Cholla Power Plant	7	0.3%
Port of Tucson	5	0.2%
Drake Switching Company	4	0.1%
Kingman Terminal Railroad	3	
Subtotal Short Line Railroads	**561**	**27.7%**
Total	**2,026**	**100.0%**

Source: Arizona State Rail Plan, 2011

Arizona's Class I railroad systems support two distinct types of operations: Transcontinental movements that pass through the state without stopping except for train crew changes, refueling, and/or inspections; and regional movements that provide branch line service primarily into and out of Phoenix.

Arizona's Transcontinental Rail Corridors

Two of the nation's four transcontinental rail corridors traverse Arizona: BNSF's Transcon Corridor and UPRR's Sunset Route link Southern California—including the Ports of Los Angeles and Long Beach – to Chicago and Dallas, respectively. These routes each serve as a 'land bridge' to convey trade by rail between Asia and the Eastern United States (in lieu of the Panama Canal). Other transcontinental corridors include UPRR's Overland Route, which roughly follows I-80 from California to Chicago, and BNSF's Great Northern Corridor, which connects Seattle and Chicago along the I-90/I-94 corridor.

The **BNSF Transcon** connects Southern California with Kansas City, Chicago, and points in the Midwest and Northeast U.S. and runs along the I-40 corridor in Arizona.

UPRR's Sunset Route connects Southern California and Arizona to El Paso, Dallas, and points in the Southeast U.S. and runs along the I-10 and I-8 corridors in Arizona.

Photos: Clay Gilliand, 2013, Creative Commons.

3.1.2 Transcontinental Routes

BNSF Railway's main line, its Transcon Corridor, is the primary national freight rail corridor through Arizona (connecting Los Angeles to Chicago) and passes through northern Arizona along the I-40 corridor via (from west-to-east) Kingman, Williams, Flagstaff, Winslow, and Holbrook. UPRR's main line, the Sunset Route, also connects with Los Angeles but through Yuma in the southern part of the state parallel with I-10 and I-8, via (west-to-east) Wellton, Gila Bend, Maricopa, Casa Grande, Tucson, Benson, and Willcox. Both Class I railroads carry Amtrak passenger rail trains, including Southwest Chief intercity services on BNSF Railway tracks and Sunset Limited/Texas Eagle services on UPRR tracks.

3.1.3 Class I Branch Lines

Both Class I railroads utilize branch lines to move freight into and out of the Phoenix area and other Arizona regions. These branch lines connect to the transcontinental corridors and include (also shown in Figure 20):

- **BNSF Railway Branch Lines** – Phoenix Subdivision (209 route miles); Coronado Subdivision (south of I-40, 45.4 route miles); and Springerville Subdivision (south of I-40, 29.7 route miles).
- **UPRR Branch Lines** – Phoenix Subdivision (125 route miles); Nogales Subdivision (65.7 route miles); and ASARCO Mission Mine Spur (6.5 route miles).

3.1.4 Short Lines

Arizona's short line railroads are, for the most part, connected with the Class I railroad freight rail system, with the exception of the Black Mesa and Lake Powell Railroad in northern Arizona (also see Figure 20). These railroads, most of which were once part of the Class I railroad network, are defined as railroads operating within relatively short distances (under 350 route miles) and with low annual operating revenues (less than $40 million). The short lines also include switching and terminal railroads operated jointly by two companies to facilitate the transfer of cars between railroads. These railroads also may be operated within a facility or group of facilities (for example, mines).

3.1.5 Key Commerce Corridors

As presented in Section 2 above, ADOT prepared an analysis of Arizona's Key Commerce Corridors and is preparing a series of "Corridor Profiles," to define future transportation infrastructure priorities for all modes and systems, including freight rail. As part of this process, ADOT is identifying needs, deficiencies, and potential transportation infrastructure solutions, which will be used to support future multimodal planning efforts. As shown in Figure 22, most of BNSF Railway's and UPRR's main line and branch line services fall within ADOT's Key Commerce Corridors and the Corridor Profiles currently under analysis.

Figure 22: Arizona Freight Rail in the State's Key Commerce Corridors

Railroad		Corresponding Key Commerce Corridors
BNSF Railway	Transcon	• I-40, New Mexico to California
	Phoenix Subdivision	• I-17, Flagstaff to Phoenix • I-11 (SR 93, U.S. 60), Phoenix to Wickenburg
Union Pacific Railroad	Sunset Route	• I-10, NM Border to Tucson to Casa Grande • I-8, Casa Grande to Yuma (CA Border)
	Phoenix Subdivision	• I-10, Casa Grande to Phoenix • I-10, Phoenix to Yuma (CA Border)
	Nogales Subdivision	• I-19, U.S./Mexico to Tucson
Arizona Eastern Railway	Arizona Eastern Railway	• Portions of U.S. Route 191, U.S. Route 70, and portions of the U.S. Route 60 highway corridors east and north of Tucson

3.1.6 Intermodal Terminals

As shown in Figure 23, Arizona's Class I carriers serve more than 15 intermodal terminals of varying size and purpose—each providing access between the rail and highway systems. Four of the terminals are major intermodal facilities—BNSF's (Phoenix) Glendale Terminal, Union Pacific's Phoenix Express Terminal, Union Pacific Tucson Intermodal Terminal, and the Port of Tucson (served by Union Pacific). These four terminals accommodate regularly scheduled trains and provide loading and unloading of containers and trailers to and from railroad flatcars and trucks. The remaining terminals are either modestly sized intermodal terminals or container yard depots[15]. Intermodal is growing faster than any other mode of transportation in the U.S. and according to consultations, demand for intermodal service in Arizona is likewise strong and growing.[16]

Figure 23: Arizona's Key Intermodal Facilities

Intermodal Facility	Location
BNSF Railway	BNSF Kingman Airport/Industrial Park (Intermodal Facility)
	BNSF CY Deport, El Mirage Auto Distribution, Phoenix
	BNSF Mobest Yard, Phoenix (Intermodal Facility)
	BNSF Rail Terminal, Glendale (Intermodal Facility)
	BNSF CY Depot, Duncan & Son Lines, Buckeye
UPRR	UPRR Rail Terminal, Port of Tucson
	UPRR Harrison Street Yard, Phoenix (Intermodal Facility)
	UPRR CY Depot, Duncan & Sons Line, Phoenix
	UPRR CY Depot, Absolute Terminal, Phoenix
	UPRR CY Depot, Price International Southwest, Phoenix
	UPRR CY Depot, Swift Transportation, Inc., Phoenix
	UPRR CY Depot, Knight Transportation Inc., Phoenix
	UPRR CY Depot, Knight Transportation, Inc., Phoenix
	UPRR Tucson Yard, Tucson (Intermodal Facility)
	UPRR CY Depot, G. Mendez & Company, Nogales
	UPRR CY Depot, Valencia International, Inc., Nogales

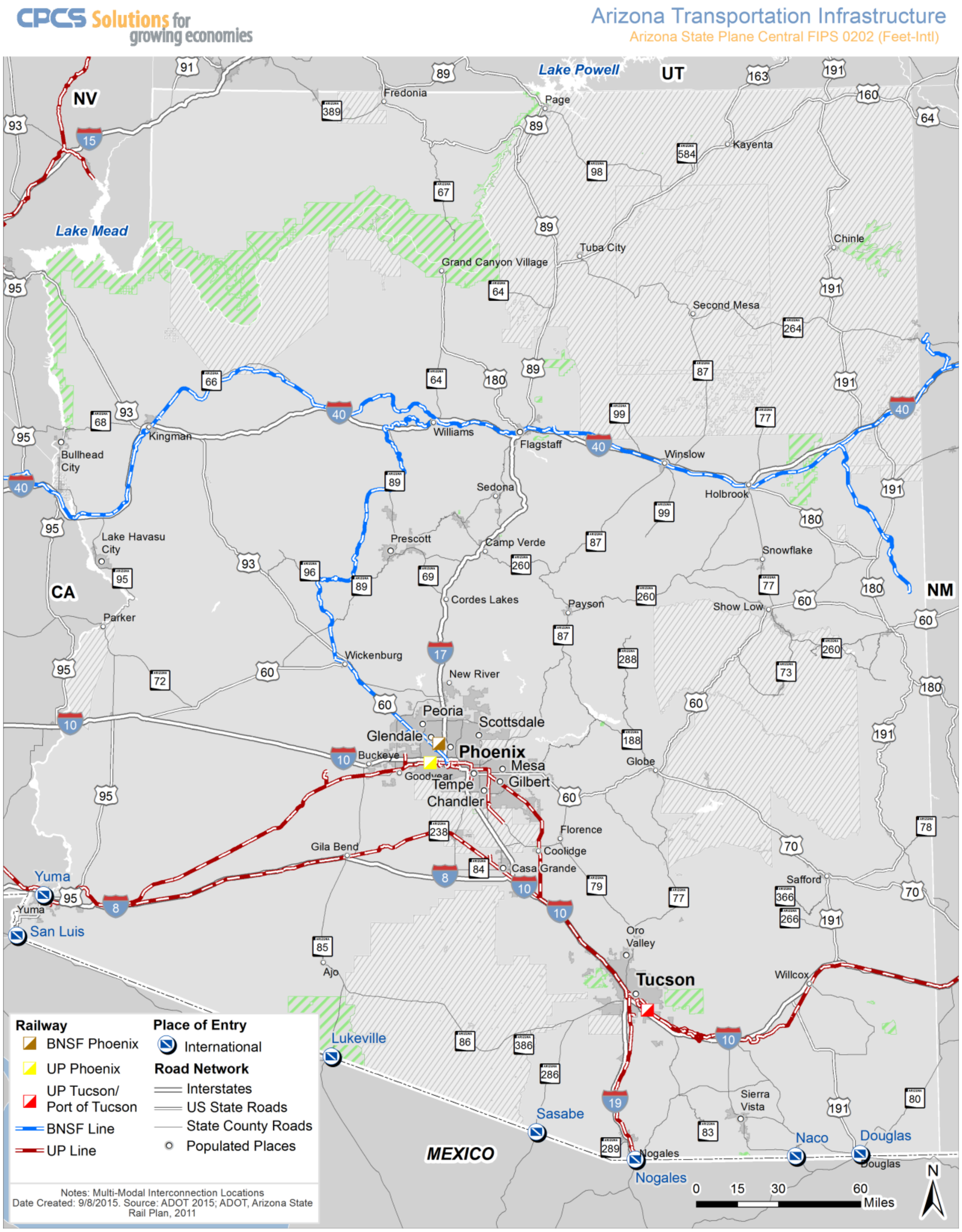
Source: Intermodal Association of America, 2015; and 2011 Arizona State Rail Plan, ADOT.

Future Intermodal Terminals

Additional intermodal facilities are currently in the planning stages for future implementation, including the Bellmont-Camp Navajo inland port and an intermodal facility in northern Arizona on the BNSF Trancon. BNSF also has plans for a new classification yard/intermodal transloading facility in Surprise (and potential inland port). A potential inland port at Yuma has been studied to serve as an interface with the UPRR Sunset Route, and a potential railroad connecting to the port at Punta Colonet, Mexico. Major intermodal terminals in Arizona are illustrated in Figure 24.

[15] Container yard depots are railroad or privately owned yards used to store containers.
[16] Intermodal Association of North America and industry consultations.

Figure 24: Location of Key Intermodal Rail Terminals Arizona



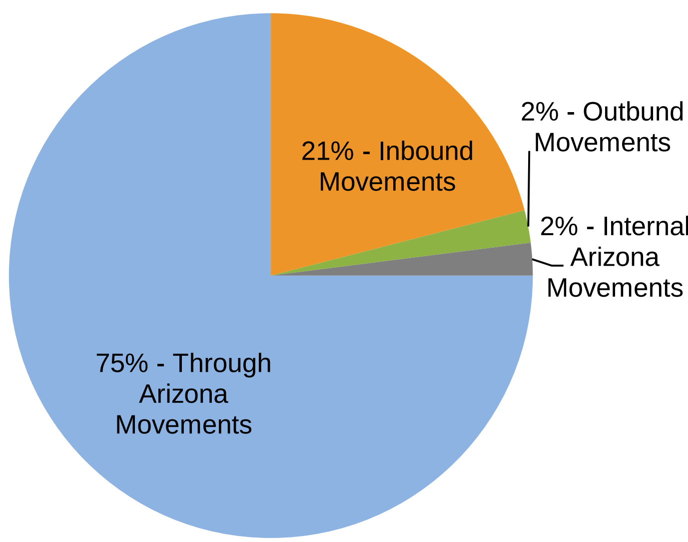
3.2 Freight Rail System Flows

The freight rail system in Arizona predominantly serves through movements, or trains passing through Arizona without specific origins or destinations in the state.

As shown in Figure 25, only about 23 percent of the total freight rail movements are currently destined for Arizona locations, according to the 2007 Arizona Multimodal Freight Analysis Study conducted by ADOT. Arizona's current distribution of freight rail movements (in tons) includes:

- 75 percent of all tonnage is through freight rail movements (freight traveling through the state from non-Arizona origins and destinations)
- 21 percent of all tonnage is inbound movements (freight destined for locations in Arizona)
- 2 percent of all tonnage is outbound movements (freight destined for locations outside of Arizona)
- 2 percent of all tonnage is traffic generated internal to Arizona (freight originating and destined for locations in Arizona)

Figure 25: Mix of Current Freight Rail Movements in Arizona

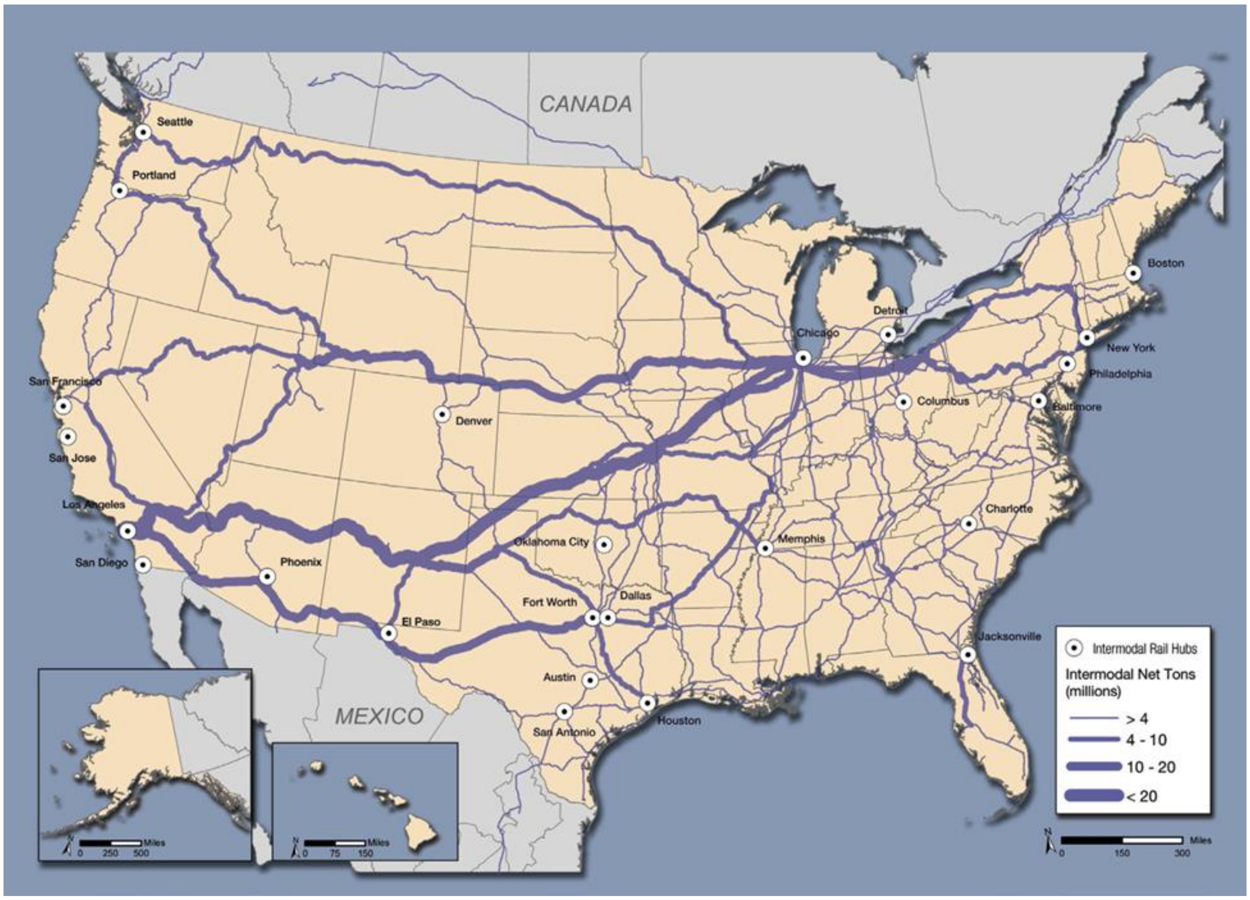


Source: 2007 Transearch Data

As with the tonnage, the value (in millions of dollars) of freight movements follows similar relationships: the predominant value of freight is moved through the state.

Figure 26 shows the predominant intermodal freight rail[17] movements through Arizona in relationship to the national rail network. Notable are the BNSF Transcon Route, in parallel with I-40, and the UPRR Sunset Route, in parallel with I-10 and I-8. Key origin and destination locations of these movements for both railroads include the Ports of Los Angeles and Long Beach to the west, and Chicago and points east for the BNSF Railway, and Dallas/Fort Worth and points east for the UPRR.

Figure 26: National Corridor Intermodal Flows 2011



Source: U.S. DOT Federal Railroad Administration, 2011

Figure 27 summarizes the current Class I railroad mainline characteristics, including primary commodities moved, number of daily trains, and annual carloads moved by the railroads. Both the BNSF Railway and UPRR move similar commodities. Each move intermodal containers, general merchandise, cement, coal, chemicals, automobiles, and lumber, while UPRR also moves copper products. BNSF Railway moves about 2.4 times the

[17] Intermodal freight rail movements consisting of intermodal containers (domestic and international) and trailers of flatcars (TOFC).

number of daily trains compared with UPRR (100 BNSF Railway trains versus 49 UPRR trains) on their respective transcontinental routes. The BNSF Railway also carries more carloads than UPRR, about 1.7 times as many (293,000 carloads for BNSF versus 168,000 for UPRR). UPRR typically moves longer trains than BNSF along its main line.

Figure 27: Arizona Class I Freight Railroad Mainline Characteristics

Railroad	Commodities Moved	Number of Daily Trains[a]	Annual Carloads[a]	Average Train Speeds[a] (mph)
BNSF Railway Transcon	Intermodal, automobiles, cement, coal, chemicals, lumber products, general merchandise	100	293,400	70
Union Pacific Railroad Sunset Route	Intermodal, automobiles, cement, coal, chemicals, lumber products, copper products, general merchandise	49	168,000	70
	Total	**168**	**461,400**	**—**

[a] from 2011 Arizona State Rail Plan
[b] from 2012 U.S. Census, Commodity Flow Survey

Figure 28 summarizes the current short line railroad characteristics, including the primary commodities moved, number of daily trains, and annual carloads. Each move a variety of commodities, largely based on private business operations related to construction and transporting raw materials such as copper.

The number of daily carloads and annual carloads moved are considerably less than the Class I railroads, with many of the railroads not reporting daily movements.

Annual carloads for the combined active short line railroads are approximately 105,000 compared with the Class I railroads' total of 461,400 annual carloads (or approximately 77 percent less annual carloads of freight moved).

While the short line railroads primarily move goods in the mining (except oil and gas) and energy (oil and gas) economic sectors, these railroads also move limited goods related to the wholesale and retail, food and beverage, agriculture, and forestry economic sectors.

Figure 28: Arizona Short Line Freight Railroad Characteristics

Railroad	Commodities Moved	Trains Per Day[a]	Annual Carloads[a]	Average Train Speeds[a] (mph)
Apache Railway	Waste paper, coal, newsprint, animal feed	11	11,400	35
Arizona & California Railroad	Cement, lumber, liquefied petroleum, gas, steel	3	18,900	49
Arizona Central Railroad	Coal, coke, mill scale, bauxite	<1	1,200	10
Arizona Eastern Railroad	Copper ore, perlite, diesel fuel, kerosene, fertilizer	7	7,300	20
Black Mesa & Lake Powell Railroad	Coal, coke, mill scale, bauxite	n/a	8,400	40
Camp Navajo Railroad	Military loads	<1	40	10
Copper Basin Railway	Sulfuric acid, copper concentrate, copper, copper-scandium oxide	n/a	13,000	25
Freeport-McMoRan Morenci Mine	Copper concentrate, copper	n/a	n/a	n/a
Freeport-McMoRan Sierrita Mine	Copper concentrate, copper	n/a	n/a	n/a
San Pedro & Southwestern	Anhydrous ammonia, fertilizer		1,400	20
APS Cholla Power Plant	Coal, ash	<1	33,000	n/a
Port of Tucson	Container freight, intermodal-transload, frozen storage, beer, utility pipe	n/a	10,000	n/a
Drake Switching Company	Cement, raw materials	20	n/a	n/a
	Total		**104,640**	

[a] Arizona State Rail Plan, 2011

3.3 Freight Rail System Performance

The Association of American Railroads expects total national freight demand to increase 45 percent from 2012 to 2040, placing significant demand on existing infrastructure.[18] While BNSF Railway and UPRR have made significant investments in their main lines, both the railways will need to continue to expand capacity and improve infrastructure to help meet this demand. A summary of the Class I and short line railroad asset performance are presented below.

[18] *Freight Railroad Capacity and Investment.* American Association of Railroads, 2015.

3.3.1 Infrastructure Condition

Arizona's Class I railroad infrastructure is generally considered to be in good condition, especially the transcontinental routes which have been improved by UPRR and BNSF to accommodate high-speed double track service. The condition of branch lines and Class III infrastructure is more variable, with some railroads in need of significant investment in maintenance and track rehabilitation.

3.3.2 Capacity

Arizona's freight rail system is generally capable of accommodating the current demands for rail service, but there are some challenges that the railroads are considering in their capital plans, including

- Limits to rail track capacity (and the need to add sidings, double-, or triple-track segments),
- Limited north-south rail service, due in part to the historic east-west orientation of the rail network,
- Delays associated with at-grade rail crossing locations,
- Lack of intermodal infrastructure (e.g., classification yards, intermodal facilities, freight logistics centers) or a lack of land for expansion. The UPRR's Harrison Street Classification and the BNSF's Mobest yards lack capacity to expand,
- Freight is not balanced to provide Arizona loads to export out of the states (railroads do not have ample opportunity to backhaul goods from Arizona)

Class 1 Capacity Challenges and Solutions

The highest capacity rail facility in the state is BNSF's Transcon Corridor, which currently carries 100 trains per day, averaging out to a train every 15 minutes.

Similarly, the UPRR's Sunset Corridor carries 49 trains per day averaging out to a train approximately every 30 minutes. Both corridors accommodate the current level of service, but each has identified plans to expand service through Arizona. For example, UPRR has recently double-tracked several segments of the Sunset Corridor in Arizona and has completed plans to double-track the remaining segments for near-term implementation.

In its most recent rail plan, ADOT recommended potential future freight rail infrastructure expansions with both the Class I and Short Line Railroads. The expansions target north-to-south movements in Maricopa, Pinal and Pima Counties (including improvements to track capacity, and new/expanded classification yards, intermodal facilities, and freight logistic centers) to meet the needs identified above. These future expansions are designed to provide a more balanced north-to-south freight rail system and to provide greater accessibility, connectivity, and economic diversity to businesses in this corridor.

Both the BNSF Railway and UPRR have plans, some of which have already been initiated and completed, to expand the Transcon Corridor and Sunset Route, respectively. The plans aim to both reduce the impacts of bottlenecks and improve intercontinental freight rail capacity. Recent and planned improvements to freight rail infrastructure in Arizona include:

- BNSF Railway has identified plans to triple-track Transcon through Arizona as a continuation of its similar expansions in New Mexico and has already invested $47 million in 2014 for capacity expansion and maintenance in Arizona. [19]
- BNSF has located six new or expanded facilities in Arizona, which included five million dollars in investments. These infrastructure projects have included Intsel Steel West, LLC, in Surprise, and Performance Steel, Inc., and Zytech Building Systems in Glendale.[20]
- UPRR continues to double-track it's Sunset Route through Arizona to create a high-capacity freight rail service as a continuation of its capacity expansion in other states, and has invested more than $437 million in freight rail infrastructure in Arizona from 2010 to 2014.[21]
- UPRR is planning to develop a new classification yard at Red Rock on the I-10 corridor to improve efficiency in delivering carloads to Phoenix and Tucson.

Performance Effects of Capacity Expansion

Capacity expansion projects improve the movement of goods by rail and have the potential to relieve freight rail bottleneck conflicts with Amtrak passenger trains using the same tracks. Additionally, BNSF and UPRR plan to build or expand new terminal facilities, including BNSF's Bellmont-Camp Navajo inland port, intermodal transloading facility in Surprise, and UPRR's classification yard facility at Red Rock. All of these projects are designed to reduce freight rail system bottlenecks. In addition, both the BNSF Railway and UPRR have proposed rail yard capacity expansion projects in both Phoenix and Tucson to be able to handle more freight rail traffic. These expansion plans offer the Class I freight railroads an opportunity to move more goods to and from Arizona.

In the *Arizona State Rail Plan,* ADOT identified transcontinental expansion projects and intermodal facilities as an opportunity to help expand freight movement capacities through public private partnerships and by streamlining the permit processes for new infrastructure improvements. The mitigation of freight rail grade crossings is also being addressed by ADOT, freight railroads, and the Federal Railroad Administration. These efforts will also

[19] *The BNSF Railway Service in Arizona Fact Sheet*. Burlington Northern Railroad, 2014.
[20] ibid
[21] *Union Pacific in Arizona Fact Sheet.* Union Pacific Railroad, 2014.

help reduce bottlenecks in Flagstaff, Maricopa, Nogales, and Tucson, many of which have been under evaluation for years to identify cost-effective solutions. [22]

Short Line Capacity Challenges and Solutions

Consultations were conducted with selected short line railroads to identify and document issues and concerns regarding operational and infrastructure conditions, needs, and potential projects and strategies to meet these needs. To date, five short line railroads responded to the consultation interviews and provided the following information on challenges and potential solutions.

- **Track maintenance/service issues.** Short line carriers would like to see Arizona develop a state rail funding program (including public-private partnership opportunities) for rail development for projects that:
    - Improve rail infrastructure and promote new rail-supported development,
    - Provide help with short line railroad track maintenance,
    - Improve Class I/short line railroad interchanges (to reduce congestion and border crossing impacts) and data transfer processes, and
    - Improve Class I service issues that delay movements and result in customer service impacts.

Railroads felt that these policies would improve system safety and efficiency and help expand Arizona's economy. Conversely, if these improvements were not made, then the railroads felt that new business opportunities would be lost and railroads would potentially be abandoned.

3.3.3 Freight Rail Operational and Infrastructure Problems and Needs

Several railroads did not identify any specific safety issues that need to be addressed, while others suggested the following:

- Safety can always be improved and is an ongoing top priority.
- Most railroads responded that there were no known multimodal bottlenecks impeding the efficiency of their freight rail operations
- One railroad cited the need to improve the U.S.-Mexico freight rail connection in Nogales (both sides of the border).
- Improvements to and development of additional intermodal facilities would increase the potential for linking Arizona's freight rail system to other regions in the United States.

[22] *2011 Arizona State Rail Plan*. Arizona Department of Transportation, 2011. Link.

- Improvement of Class I/short line railroad interchanges would reduce congestion and border crossing impacts

3.3.4 Potential Freight Rail Projects and Strategies for Investment Needed for Arizona

Railroads were also asked about the types of factors that ADOT should consider in making freight rail transportation infrastructure decisions. Some offered no opinion, while others suggested the use of public and private benefits to help expand services, create jobs in remote regions where unemployment is highest, capture new industries that would benefit from rail services, and invest in policies to shift large truck traffic to rail to reduce roadway damage and air emissions.

The railroads felt that ADOT could provide better service by providing simple monthly or quarterly reports on how it is addressing freight railroad issues and concerns. Many of the railroads felt that ADOT was providing good services. The possibility of ADOT forming a short line railroad association was suggested as a means to help the state and railroads coordinate ongoing and future opportunities to meet the needs of its customers.

Shortline Funding Challenges

In 2013-14, the Apache Railway of Snowflake, AZ unsuccessfully solicited help from the Arizona Commerce Authority (ACA) for over $2 million in loans to help the railroad stay in business after losing its largest customer, a paper mill. Recently, the Apache Railway has seen business climb and has been soliciting a rural transportation loan from the US Department of Agriculture as a method of remaining solvent, while they bring on new business and paying off their original creditor.

3.3.5 Speed

BNSF Railway's freight trains on the Transcon Corridor average 70 mph, with speeds varying in segments, while freight trains average 49 mph on the BNSF Railway Phoenix Subdivision. UPRR's freight trains on the Sunset Corridor average 70 mph. The intermodal goods moved on the transcontinental lines are time-sensitive. These average travel speeds are relatively consistent with BNSF's Transcon and UPRR's Sunset Corridors in other states, depending on the number of at-grade crossing locations and urban versus rural nature of the services.

3.4 Freight Rail Policy and Regulatory Issues

Several policy and regulatory issues affect the performance of Arizona's freight rail system, both negatively and positively.[23] These policy and regulatory issues include:

- **Funding Infrastructure Improvements -** Class I railroads own and operate the freight rail systems in Arizona. They plan, program, finance and implement infrastructure improvements. These private companies, while historically investing millions of dollars in freight rail infrastructure improvements in Arizona (and across the nation), experience financial issues that affect implementation strategies. For example, given the recent economic downturn, BNSF Railway held back on triple-tracking plans for the Transcon Corridor. Funding infrastructure improvements is difficult in this economic climate regardless of public or private sector orientation.
- **Rail Safety and Security -** The Federal Railroad Administration, American Association of Railroads, and the nation's freight railroads expend significant resources to define policies and regulations to ensure the safe and secure movement of goods. The focus of rail security is more recently concerned with the threat of terrorism on the national rail network and the possibility that such acts could disrupt transportation or harm citizens. Federal agencies cooperate with the freight railroads to improve rail safety and security in Arizona. In addition, the need to provide safe transport related to the movement of hazardous materials receives significant attention from the freight railroads, as well as federal regulatory oversight. There is an inherent tradeoff when safety measures affect the efficiency of rail operations, while system safety at the local, regional, state, and federal levels enhances ADOT's ability to expand and improve its freight rail network.
- **Positive Train Control Deployment and Investment -** Positive train control (PTC) include advanced technologies designed to stop or slow trains before train-to-train collisions, derailments caused by excessive speeds, unauthorized incursions by trains onto tracks where maintenance activities are underway, and movements of trains through track switches in the wrong position.[24] The full deployment and implementation of PTC technology across 60,000 route miles of the nation's freight rail system is both costly and time-consuming and is a major focus of the freight railroad industry. These technologies will help improve freight rail safety and enhance the movements of goods.
- **Economic Regulation -** The U.S. Surface Transportation Board is responsible for the economic regulation of the railroad industry, including the responsibility for ensuring

[23] 2011 Arizona State Rail Plan, ADOT; and Association of American Railroads, Fact Sheets, 2015.
[24] Association of American Railroads, Positive Train Control Fact Sheet, 2015.

that railroad investments are defined through policy initiatives. The foundation for this regulation is the Staggers Act of 1980, which has allowed for a balanced regulatory structure and has enabled these private companies to invest billions of dollars back into the nation's freight rail system.[25]

- **Supporting Economic Development through Freight Rail –** As Arizona grows and develops, it will be important to include the thoughtful and efficient integration of freight rail. Using, maintaining, and improving Arizona's existing freight rail network will allow continued growth in the mining and agricultural industries. Additional freight capacity may help mitigate some highway-related issues (congestion, emissions, etc.). Transportation improvement strategies, including those involving freight rail, will need to continue to be designed by ADOT for future implementation.

- **Livability and Quality of Life -** The livability of communities can be enhanced by freight rail if it provides efficient transport of goods and access to centers of economic activity. Preserving and expanding the rail network may allow more efficient delivery of goods, provide lower shipping costs, reduce fuel consumption, lower environmental emissions, result in fewer accidents, and lessen noise disruption. As with sustainability and economic development policies presented above, ADOT must continue to ensure that public and private livability and quality of life goals are met as they design and implement future projects for all systems and modes.

Port of Tucson

The Port of Tucson is a privately owned intermodal rail facility located on I-10 and the Union Pacific Sunset Route near Tucson International Airport. The Port:

- Is an inland port providing international intermodal shipments in the Southwest.
- Has 1.8M square feet of warehousing, distribution and manufacturing facilities and is a designated Foreign Trade Zone.
- Is hub of Mexican beer distribution to entire Southwest U.S. given its strategic location.

- **Energy Use and Costs -** Freight railroads are continually working to improve fuel efficiency. There is considerable evidence that rail transport is already less energy intensive and more cost efficient than highway transport. Investments in future freight

[25] Association of American Railroads, Economic Regulation Fact Sheet, 2015.

rail system investments have the potential for the state to reduce energy use and costs.[26]

- **Environmental Damage and Costs (Air Quality) -** The January 2011 U.S. Government Accountability Office report GAO-11-134 notes trucks have the highest rates of emissions per ton for each of the emissions presented. The total value per million ton-miles, in 2010 dollars, is $41,480 for trucks and $6,710 for rail.[27] As with many of the other policies and regulations presented above, the movement of increased goods via freight rail provides an opportunity for ADOT to reduce future statewide environmental impacts.

A variety of other regulatory issues may affect freight rail in Arizona in the near- and long-term, depending on the implementation of potential national policies. These may include changes in crew size regulations, which may increase due to the deployment of PTC, and funding policies to ensure adequate rail capacity, among others.

[26] According to AAR, in 2012 U.S. freight railroads moved one ton of freight four hundred and seventy-six miles on one gallon of diesel fuel—four times the efficiency of truck travel. Additionally, AASHTO has concluded that for every one percent of long-haul freight diverted from truck to rail would result in a savings of 111 million gallons of fuel per year.

[27] GAO-11-134, January 2011, Table 8, page 49.

4 Air Cargo System

Key Messages

Phoenix Sky Harbor International Airport (PHX) moves nearly 90 percent of all air cargo originating or terminating in Arizona. Tucson International Airport (TUS) handles nearly ten percent of the state's air cargo.

Integrators such as FedEx and UPS have increasingly expanded their market share in the movement of air cargo. In 2013, only 13 percent of air cargo in Arizona was carried on passenger aircraft.

While estimates suggest no new on-airport cargo infrastructure will be needed until 2031, highway access to air cargo facilities at PHX, especially the South Air Cargo complex, will need to be addressed.

4.1 Arizona's Air Cargo System Assets

The air cargo industry in Arizona features a mix of large air carrier airports and smaller regional airports. Air cargo activity is highly concentrated at Phoenix Sky Harbor International Airport (PHX) and Tucson International Airport (TUS), corresponding to over 99 percent of inbound and outbound cargo and about 95 percent of passengers in 2014.[28] The remaining freight is processed through Yuma International Airport, Flagstaff Pulliam Airport, and Lake Havasu City Airport. This chapter will focus primarily on PHX and TUS.

Phoenix Sky Harbor International Airport

Phoenix Sky Harbor is the largest airport in Arizona in term of cargo and passengers enplaned. When measuring based on total cargo, Sky Harbor ranked 20th in the US in 2013 according to Airports Council International. Sky Harbor is critical to Arizona and enplaned between 88 and 89 percent of all cargo and passengers originating in or destined for Arizona in 2013.

4.1.1 Overview of Air Cargo Freight System Characteristics

The nature of goods traveling as air cargo is extremely diverse. Air cargo is typically the most expensive mode of goods transportation, but shippers pay this price premium for a variety of reasons, including:

- High-value products where transportation costs are marginal
- Time-critical demands, where speed is vital (for example, produce, seafood, medicines)
- Factors such as stock holding and inventory cost, which can be reduced because of quicker transit times with air cargo services
- Improved security and reliability

Integrators – who own all assets of production from shipper to consignee and offer door-to-door service including air cargo and any other mode of transportation needed to move freight from origin to destination. In this capacity they are both forwarders and carriers of the freight. The Integrators market is dominated by four large players: FedEx, UPS, TNT, and DHL.[29]

[28] Air Carrier Statistics Database. Bureau of Transportation Statistics.
[29] Hoel, L, G. Giuliano., and M. Meyer. *Intermodal Transportation: Moving Freight in a Global Economy*. Eno Foundation for Transportation, 2011.

Non-integrators – non-asset based forwarder and airlines. The forwarder organizes the carrying and delivery of cargo and airlines provide airport-to-airport transportation services organized by the forwarder. The forwarder then will contract with landside transportation to move the cargo to and from the airport.

Air cargo may be carried using the following methods of transportation, all of which are used in Arizona:

- On passenger aircraft (known as belly hold cargo)
- On freighter aircraft
- On freighter aircraft operated by integrators such as DHL, FedEx, and UPS
- On a truck with a flight number—known as a road feeder system. For example, a consignment of goods moving from Phoenix to Frankfurt, Germany, may be received at an air terminal in Phoenix and assigned to a "flight" from Phoenix to Los Angeles that is a truck. The leg from Los Angeles to Frankfurt is then made by air.

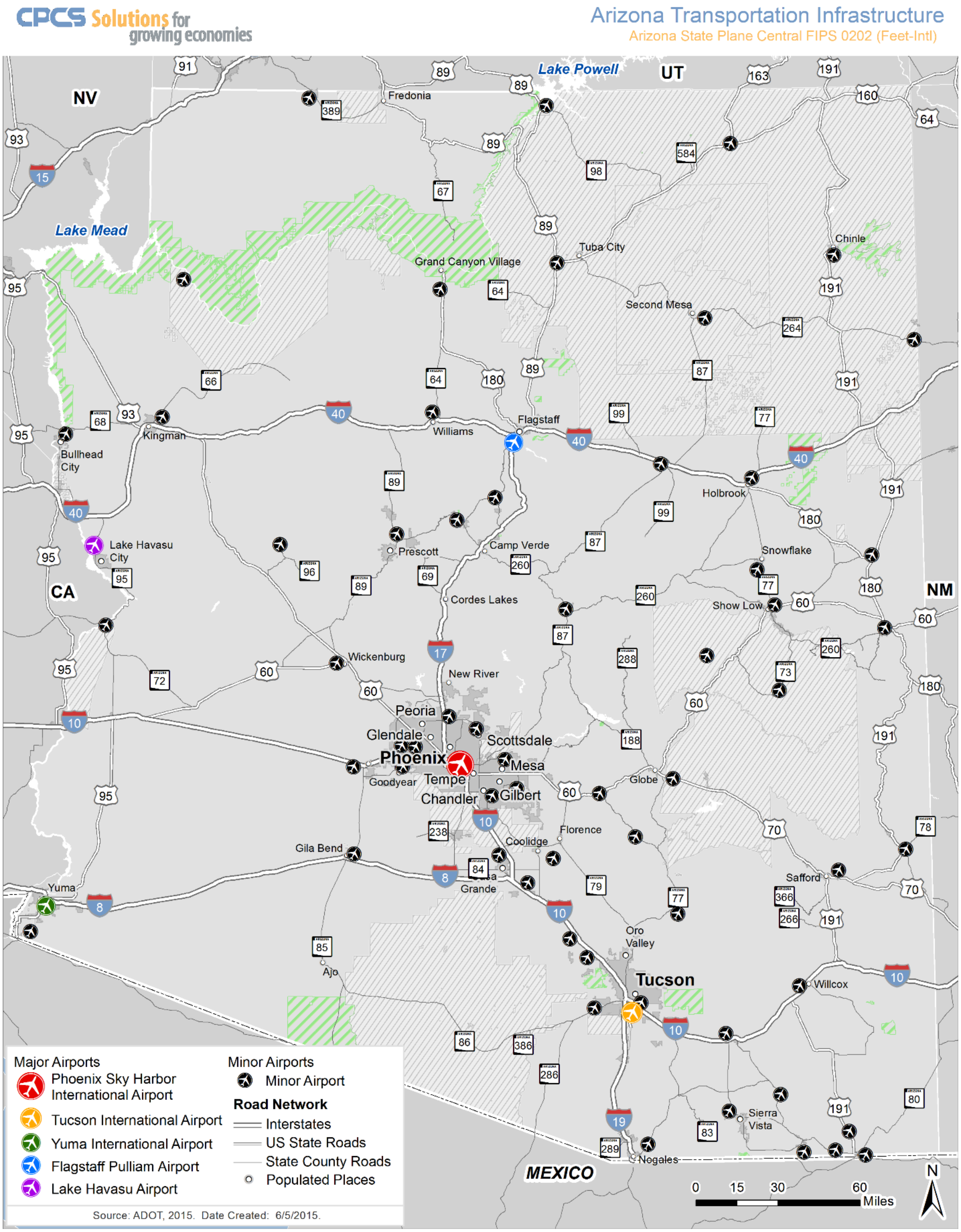
Air cargo flows through the freight system and uses a number of components that facilitate movement (Figure 29).

Figure 29: Air Cargo Components

Air Cargo Component	Constituent Parts
Airspace environment	Air traffic control, airways, approaches to airports
Air transport operator	Passenger aircraft carrying cargo, freighter aircraft
Airport environment	Runways, taxiways, aprons/aircraft stands, ground handling equipment, internal airport road network
Cargo facilities	Warehouses, truck access, access to aircraft
Landside transport network	Road access to the airport and cargo terminals

Many of the system components are used by both passenger and air cargo operations, even though it is typical for air cargo handling facilities at airports to have no direct relationship with passenger operations. However, there are different characteristics associated with the cargo facilities used by integrators versus those used by passenger airlines and non-integrators. One difference in the characteristics of cargo facilities is the hours of peaks of activity. Additionally, integrators want to have direct and quick links to integrator freighter aircraft, while conventional facilities will often have cargo delivered from a passenger aircraft that has arrived at a passenger terminal.

Figure 30: Arizona's Airports



4.1.2 Key Air Cargo Facilities

Integrators such as FedEx and UPS maintain dedicated facilities that are separated from commercial passenger aircraft at both PHX and TUS. At PHX, there are two separate facilities, the South Air Cargo complex and the West Air Cargo complex shown in Figure 31. Both of the air cargo complexes provide ample aircraft parking aprons for the volume of air cargo traffic. At TUS, separate air cargo facilities are located southeast of the main terminal. All air cargo integrators use a shared aircraft apron at TUS, which provides sufficient capacity for the current and near-term air cargo needs.

Figure 31: Phoenix Sky Harbor Key Air Cargo Facilities

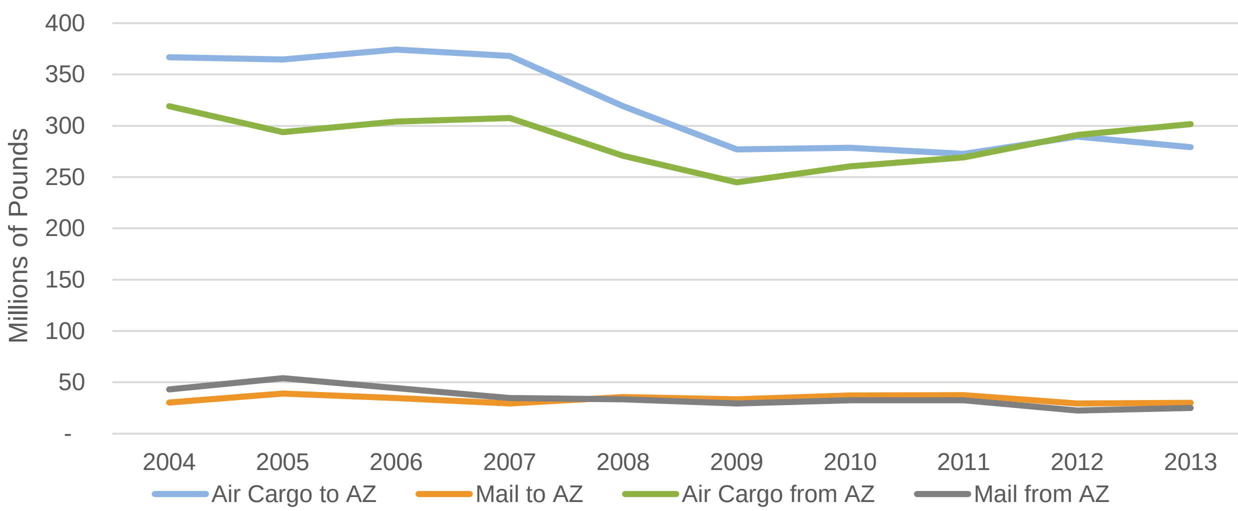
Source: Phoenix Regional Air Cargo Planning Study

An important element of air cargo operations is the capacity and quality of the airfield system. PHX has a three-runway airfield system with all runways constructed of Portland cement concrete pavement. With the addition of the third runway in 2000, PHX has sufficient capacity for airfield operations. The airfield system at TUS consists of two air carrier runways and one general aviation runway. All of the runways at TUS are constructed with asphaltic concrete pavement and are in good to fair condition. The primary runway is currently in the process of being reconstructed, having experienced significant pavement distress over the past several years.

4.2 Air Cargo System Flows

Figure 32 illustrates that air cargo has significantly declined from the peak in 2004. Comparing volumes in 2004 with those in 2013 shows a 24 percent reduction in air cargo imported to Arizona, a modest reduction in cargo exported from Arizona, a 6 percent decline in mail imported, but a 42 percent reduction in mail exported from Arizona. The decline in volumes is attributed to many factors including the effects of the 2008 recession, reduction in domestic cargo capacity on passenger airlines (belly cargo), security restrictions associated with cargo on passenger aircraft, and shippers using cheaper modes such as trucking. However, particularly noteworthy is the rebound in air cargo exported from Arizona following the recession.

Figure 32: Air Cargo to and from Arizona



Source: Bureau of Transportation Statistics (2014)

4.2.1 PHX Air Cargo Operations

Air cargo operations at PHX are dominated by the integrators Federal Express Corporation (FedEx) and United Parcel Service (UPS). In 2004, FedEx had a 38 percent share of exports, but by 2013 this had grown to 52.7 percent. UPS comprises 28.3 percent of cargo exported by out of PHX in 2013, making UPS and FedEx responsible for 81 percent of all air cargo exports.[30] The reason that Phoenix's air cargo volume is dominated by FedEx and UPS is that it is utilised as a mini hub. This mini hub has a number of different operations:

1. Small aircraft that depart from other Arizona airports including Lake Havasu (airport code HII), Flagstaff (FLG) and Yuma (NYL) either once or twice a day carrying cargo to the integrators' main and regional hubs to connect with outgoing flights. These small

[30] Air Carrier Statistics Database. Bureau of Transportation Statistics.

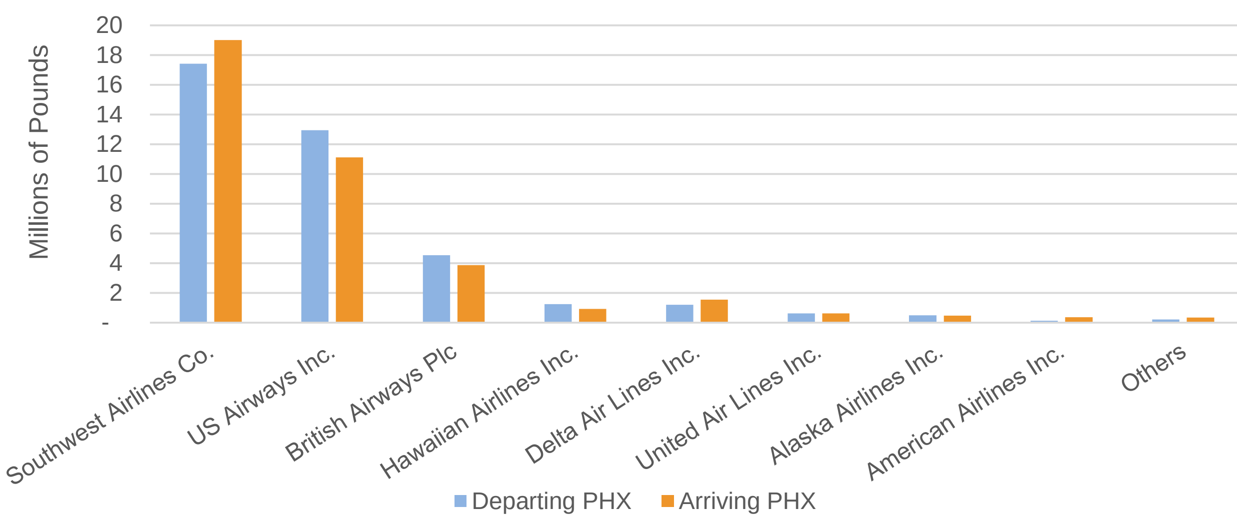
feeder flights also carry cargo back to these airports, typically during the early morning.

2. A sortation facility that sorts cargo and loads aircraft serving either a regional or main hub. For example a piece of cargo traveling from Phoenix to San Francisco with FedEx is most likely to fly to FedEx's western regional hub at Oakland, CA. Cargo destined for the East coast is more than likely to transfer through either the main hub at Memphis or a secondary hub at Indianapolis.

3. A ground distribution operation that connects incoming and outgoing flights with the integrator's ground transport network. Cargo originating in or destined for Phoenix and surrounding towns and cities will typically be transported to and from the airport by truck.

Cargo carried on passenger aircraft is dominated by Southwest Airlines, with 47 percent of all cargo carried on passenger aircraft to and from Phoenix (Figure 33).

Figure 33: Cargo Carried on Passenger Aircraft to and from Phoenix



Source: Phoenix Sky Harbor International Airport

4.3 Air Cargo System Performance

Arizona's air cargo airports serve the current air shipping needs of the state's businesses and consumers. This section examines the current conditions at the state's air cargo airports with a focus on the Tucson International Airport. This analysis focuses primarily on PHX because it handles the overwhelming majority of air cargo operations in Arizona.

4.3.1 Infrastructure Conditions

Air cargo operations are typically separate from commercial passenger aircraft operations, and require their own dedicated facilities. PHX has aircraft parking positions for both cargo operations and overnight parking (or daytime idle parking). As cargo operations increase, infrastructure elements such as cargo ramps for both operations and aircraft parking at key airports must be expanded to meet the growing demand.

Capacity

PHX currently operates two separate areas exclusively dedicated to air cargo operations: the South Air Cargo complex and the West Air Cargo complex. The South Air Cargo complex contains a single building that houses FedEx, UPS, and U.S. Customs. The West Air Cargo complex consists of three buildings that house cargo operations for Southwest Airlines, American Airlines, Delta Air Lines, and some of the smaller integrated carriers such as ABX Air and Ameriflight. Based on recent reports, additional cargo infrastructure will not be required for PHX until 2031 to meet demand (City of Phoenix 2014).

Airport Landside Infrastructure

Both the South Air Cargo complex and the West Air Cargo complex are accessed from the west side of the airport. The South Air Cargo complex is accessed by Old Tower Road, which is essentially a one mile cul-de-sac that also provides access to an Arizona Air National Guard facility. This segment of Old Tower Road is one lane in each direction and connects with 24th Street. Both 24th Street and Old Tower Road traverse the Runway Protection Zone (RPZ) for the south runway at PHX. While access is currently allowed by the Federal Aviation Administration (FAA) through a "grandfathered" approval, new regulations regarding permissible land uses within an RPZ are expected to be released in late 2015, possibly affecting how the South Air Cargo complex is accessed. The West Air Cargo complex is located along Buckeye Road, which is also accessed from either 24th Street or directly from westbound traffic I-10. Accessing the West Air Cargo complex does not affect existing airspace on the airport.

4.3.2 Air Cargo Policy and Regulatory Issues

The Transportation Security Administration (TSA) is primarily responsible, along with other governmental agencies, for developing air cargo regulations, technological solutions, and policies that continuously enhance the security of the air cargo supply chain while maintaining TSA's commitment to ensure the flow of commerce. The increase in security regulations since the 9/11 terrorist attacks has resulted in higher shipping costs and additional logistics in delivery. TSA has mandated 100 percent screening air Cargo that is “belly shipped” on commercial passenger aircraft. These screening regulations do not apply to cargo carried on freighter aircraft.

Within the air cargo industry, there is an interest to utilize centralized air cargo screening facilities which meet TSA security requirements, helping to minimize their capital investments. Currently, the closest centralized air cargo screening facility is associated with Los Angeles International Airport, which serves as a gateway airport. Given that neither PHX nor TUS are gateway airports, there is a natural incentive for freight forwarders to route air cargo to LAX rather than PHX or TUS. On a positive note, some PHX area forwarders do not route air cargo to LAX for fear of missing airline cut-off time due to heavy air cargo volumes.

5 Pipeline System

Key Messages

Two major pipelines – both operated by Kinder Morgan - supply Arizona with petroleum products. The "West Line" supplies products from the Los Angeles basin to Phoenix while the "East Line" originates in El Paso, Texas and connects to both Tucson and Phoenix. Liquid products are typically delivered to the end user by tanker truck from distribution terminals. Given the limited oil and gas production in the state, there are effectively no gathering pipelines in Arizona.

Most of the gas consumed in Arizona relies on truck deliveries which are made via one of the ten interstate gas pipelines. Natural gas is distributed to end users by pipeline.

Because pipelines are controlled by private businesses, information on their performance is difficult to ascertain.

5.1 Arizona's Pipline System Assets

Arizona has over 46,700 miles of pipelines.[32] These pipelines are mainly used for carrying natural gas, natural gas liquids, and refined petroleum products. They are generally privately owned and operated, and typically buried.

National Modal Share for Pipeline

In the United States, pipelines account for only two percent of the nation's freight transportation bill, but carry 17 percent of all freight by value[31]

5.1.1 Key Pipeline Facilites

Pipelines fall into three main categories: gathering pipelines, transmission pipelines, and distribution pipelines. Each of these serves a particular function and together form a pipeline network.

Gathering Pipelines

Crude oil, natural gas, and other bulk gases/liquids from production areas (such as wellheads) are transported through "gathering pipelines" to processing and refining facilities. PHMSA does not list any gathering pipeline networks in Arizona (2013). There are effectively no gathering pipelines in Arizona, given the limited oil and gas production in the State. For example, gas gathering pipelines in Arizona total to only about one mile.[33]

Oil and Gas Production in Arizona is Limited

Oil production in Arizona is minimal. In 2014, there were 19 oil-producing wells in Arizona. Total production reached 56,239 barrels. Nacogdoches Oil and Gas Inc. and the Navajo Nation Oil & Gas Co. were the two major well operators. Production occurred in three distinct fields (Dineh-bi-Keyah, Dry Mesa and Black Rock) located in Apache County.

Natural gas production is also minimal in Arizona. The Energy Information Administration (EIA) reports that there were five gas wells in operation in Arizona in 2013. Production, which averaged nearly 450 million cubic feet (mcf) between 2000 and 2009, decreased significantly in 2010 to about 183 mcf.[34] The decline continued in following years, reaching 12.4 mcf in 2014[35]. It is not expected that production will increase in the short to medium terms because most wells are reaching the end of their productive life. This production also occurs in Apache County but it is essentially concentrated in the Dry Mesa and Black Rock fields.

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[31] Phillips 66. 2012. "Meeting Minutes, Phillips 66, Billings Refinery, Citizens Advisory Council, October." Link.
[32] Pipeline and Hazardous Materials Safety Administration (PHMSA). 2014. "Data and Statistics." Link.
[33] Ibid
[34] Arizona Natural Gas Marketed Production. U.S. Energy Information Administration. Link.
[35], *Oil, Gas, Helium Production Report – December 2014.* Arizona Geological Survey, 2014.

Transmission Pipelines

For long distance applications, "transmission pipelines" are used to transport crude oil, natural gas, and refined products from refineries and processing centers. These may end at:

- Distribution terminals
- Large industrial users
- Custody transfer stations to distribution companies
- Power-generating facilities

These pipelines are typically large-diameter, high-pressure lines. Sometimes lateral pipelines branch off from the main transmission line to serve groups or individual users.

Two major pipelines supply Arizona with petroleum products—a 20-inch diameter, 515-mile pipeline that supplies products from the Los Angeles basin to Phoenix (the West Line) and a 400-mile smaller diameter pipeline (the East Line) originating in El Paso, Texas that connects both Tucson and Phoenix,[36] shown in Figure 35. These pipelines are part of Kinder Morgan's SFPP Southern Region. Over 560 miles of this pipeline system runs through Arizona.

Unless it is liquefied, natural gas is difficult to store efficiently and there are no underground gas storage facilities in Arizona. Gas is thus supplied directly to consumers through distribution pipelines. No major natural gas trading hubs are located in Arizona. However, the state is located on a significant natural gas transportation corridor. Arizona has approximately 6,700 miles of gas transmission pipelines. Over 90 percent of these pipelines are interstate pipelines.[37] Most of the pipeline gas entering Arizona simply passes through the state to southern California. Arizona can be called a "pass-through state" for natural gas transmission. Natural gas comes into Arizona through interstate pipelines fed from New Mexico (San Juan supply basin) and Texas (Permian supply).[38]

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[36] *Products Pipelines - SFPP*. Kinder Morgan. Link.
[37] Pipeline and Hazardous Materials Safety Administration (PHMSA). 2014. "Data and Statistics." Link.
[38] Arizona Corporation Commission, Pipeline Safety Section. 2015. Link.

Distribution Pipelines

To transport refined products to end users, smaller diameter and lower pressure networks are typically used. These are called "distribution pipelines." The end users could be residential or industrial customers.

Consumers for Petroleum Products in Arizona

In 2013, the Energy Information Administration (EIA) estimates that over 87 percent of petroleum products consumed in the State were delivered to the transportation sector. The industrial sector reportedly consumed a further 10 percent, followed by the commercial (1.6 percent) and residential (1.1 percent) sectors.

Liquid products are typically delivered to the end user by tanker truck from distribution terminals. Distribution pipeline networks are mostly used to transport gases. In Arizona, the major distribution terminals for this pipeline are located in Phoenix and Tucson. Offshoots of this pipeline distribute fuel to the Luke Air Force Base, the Yuma Marine Corps Air Station, and third-party distribution terminals.

Petroleum products consumption in Arizona extensively relies on shipments made through Kinder Morgan's pipeline network which notably supplies Phoenix and Tucson with refined products.

Most of demand for natural gas is served by the interstate pipeline network operated by El Paso Natural Gas (Kinder Morgan), Transwestern Pipeline Company and Questar's Southern Trails pipeline. While the electric power generation sector makes a limited use of oil, about two-thirds of natural gas consumption in Arizona is for power production. Residential and commercial sectors consume much of the remaining share.

Other Pipelines

Natural gas liquids are hydrocarbons commonly derived during the processing of natural gas and include ethane, propane, butane, isobutane, and pentane.

Propane storage systems and distribution networks are located in Payson and Page, Arizona. These two distribution networks have a total of approximately 250 miles of pipeline, and their associated propane storage facilities allow for at least five days of supply during the peak demand to customers.

While petroleum products are generally distributed by trucks to retailers, the Luke and Davis-Monthan Air Force bases in Phoenix and Tucson are linked to Kinder Morgan's terminal facilities by six-inch pipelines.

Pipeline Terminals and Storage

There are ten active fuel terminals in Arizona as shown in Figure 34.

Figure 34: Arizona's Active Fuel Terminals

Terminal Name	Location
Caljet of America, LLC	125 North 53rd Ave, Phoenix, AZ
Arizona Fueling Facilities Corporation	4200 East Airlane Dr., Phoenix, AZ
Pro Petroleum, Inc. - Phoenix	408 S 43rd Avenue, Phoenix, AZ
SFPP, LP Phoenix Terminal	49 North 53rd Avenue, Phoenix, AZ
Holly Energy Partners - Operating LP	3605 South Dodge Blvd., Tucson, AZ
SFPP, LP	3841 East Refinery Way, Tucson, AZ
Circle K Terminal	5333 W Van Buren St, Phoenix, AZ
Liquidtitan, LLC	31645 Industrial Lane, Parker, AZ
Pro Petroleum, Inc - El Mirage	12126 W Olive Avenue, El Mirage , AZ
Lupton Petroleum Products	I-40 Exit 359 Grant Rd, Lupton, AZ

Source: Internal Revenue Service, Terminal Locations Directory (2015).

Storage systems are used to compensate for fluctuations in product demand. These are vital to pipeline systems and end users. For example, during the peak winter season, storage facilities are used to ensure residential users have natural gas when demand is at its peak. Storage facilities are used when producers are not able to match production capacity with demand.

Arizona has storage capabilities for refined petroleum products—examples are Kinder Morgan's Santa Fe Pacific Pipelines (SFPP) Phoenix and Tucson terminals, which contain a number of petroleum products storage tanks.

It was estimated in 2011 that the two petroleum products terminals of Arizona can hold about three to five average days of demand.[39] In that sense, petroleum products supply chains of Arizona were considered to be operated largely just-in-time where any disruption supply can have significant impacts on consumption. According to EIA data, average stocks of gasoline in Arizona's bulk terminals were about two million barrels in 2013 and 2014. This value was about 957,000 barrels for distillate fuels.[40] Considering an estimated consumption of 97.2 million barrels of petroleum products in 2013,[41] average stocks of petroleum products in Arizona were capable of covering about 11 days of average consumption.

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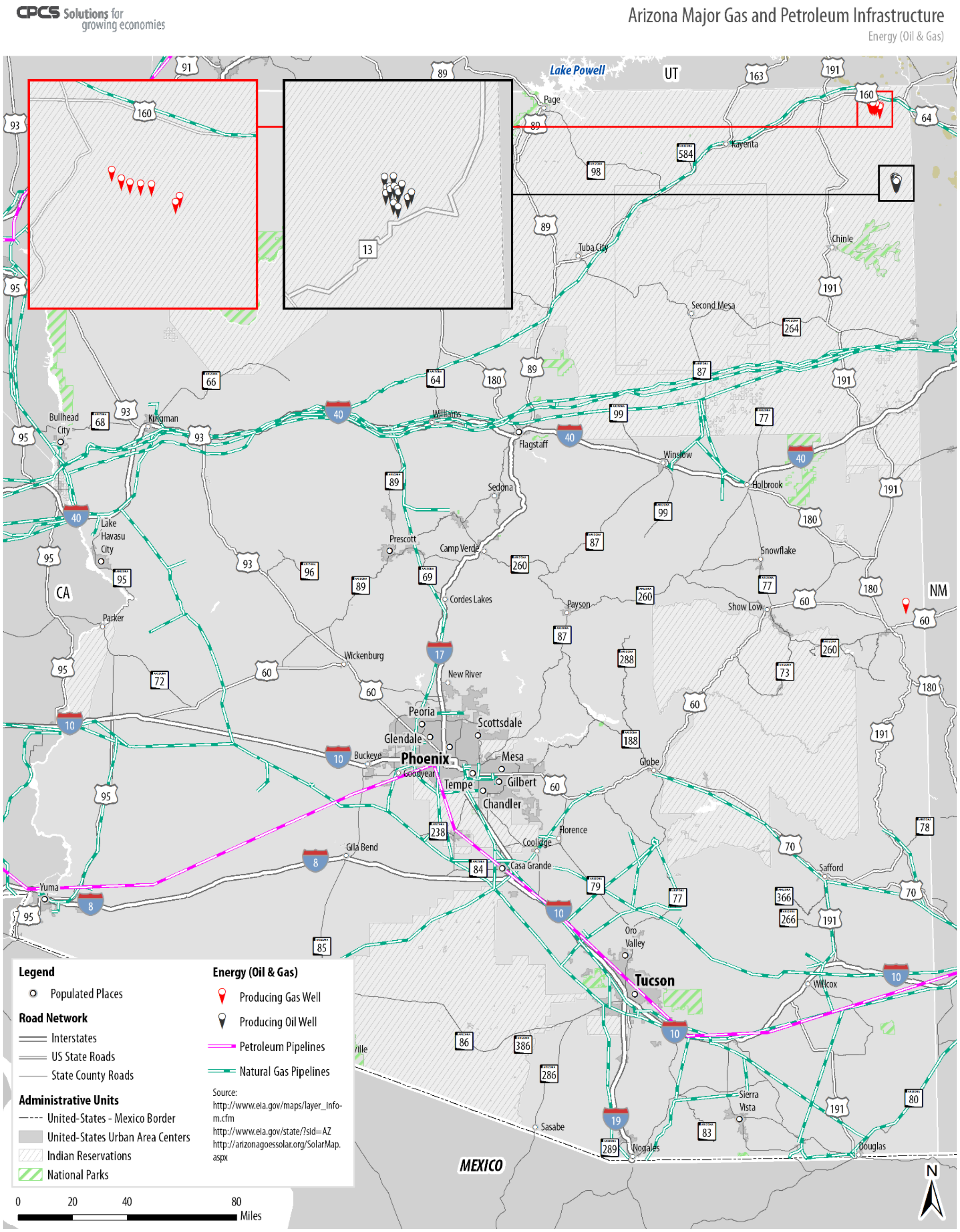
[39] Arizona State University, 2011, *Arizona's Energy Future,* Arizona Town Hall, 163 pages. This evaluation did not provide precisions on the type of demand (i.e.: wholesale, retail, industrial, etc.)
[40] Refinery, Bulk Terminal, and Natural Gas Plant Stocks by State. Energy Information Administration. Link.
[41] Profile Data. Energy Information Administration Link.

Figure 35: Arizona Pipeline Network



5.1.2 Future Pipeline and Storage Projects

There are a number of planned pipeline and storage projects planned for Arizona. These are summarized below.

Crude Oil Pipelines

With the dramatic growth in unconventional oil and liquids production, Kinder Morgan's Freedom Pipeline proposes to deliver up to 400,000 barrels per day (Bbl/d) of crude from Texas to California. Part of this project scope would involve converting an existing natural gas transmission line in Arizona for crude oil usage. This project is currently on hold because of the lack of refinery and shipper interest and competition with the rail networks to transport this crude.

Gas Storage Projects

Arizona does not have underground storage capabilities for natural gas. Attempts to construct such facilities have been burdened with a number of hurdles mostly related to environmental and financial issues.[42] Examples include a planned natural gas storage facility near Luke Air Force Base, which was rejected by the state in 2004, and the Picacho Peak Gas Storage Cavern Project, which is currently on hold.

Natural Gas Pipelines

As of May 2015, no new natural gas pipeline projects have been officially announced or filed for Arizona.[43] However, El Paso Natural Gas Company has presented preliminary options to increase capacity to its South Mainline in Arizona.

Other Pipeline Projects

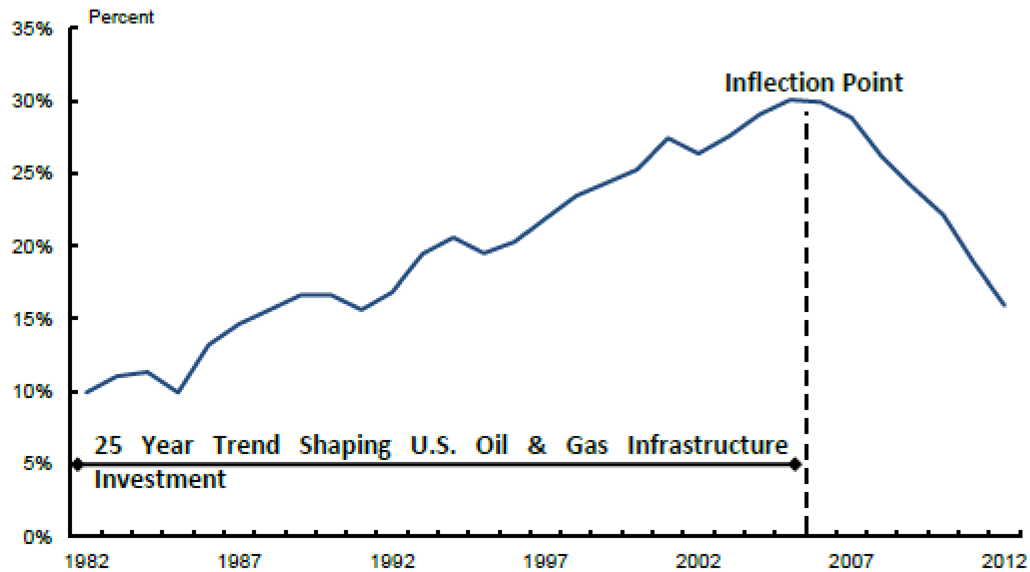
Arizona has had a previous history of helium extraction. In the last decade, exploration for helium has continued. However, there have been no confirmed helium extraction projects as of 2015.

5.1.3 Big Picture Considerations

Since the 1980s the macro trend (and also infrastructure development) was based on the United States importing energy products to meet demand (Figure 36). With shale-driven oil and gas production expanding in recent years, this trend has now reversed.

[42] *Upcoming U.S. Natural Gas Storage Facilities*. Energy Information Administration. Link.
[43] Ibid

Figure 36: US Oil and Natural Gas Consumption Supplied by Imports



Source: IHS Oil & Natural Gas Transportation & Storage Infrastructure: Status, Trends & Economic Benefits, December 2013

The most influential factor in oil and gas pipeline infrastructure today is the shale-driven production. This will likely affect Arizona's pipeline infrastructure, because the state lies on a significant U.S. pipeline corridor. It also borders Mexico, which is a market for U.S. oil and gas.

The EIA forecasts U.S. crude oil production will grow to reach 9.6 million barrels of oil per day (MMbbl/d) in 2019, effectively matching the historical high of 1970. A similar pattern would emerge with other petroleum liquids too. Major transportation infrastructure investments have already begun throughout the United States to tie in with the new production levels.

A reasonable representation of Arizona's position in this massive shift in energy balance is the Kinder Morgan Freedom Pipeline Project. As national crude oil production has ramped up and with the national trend of oil being transported to the coastal areas instead of inland, suppliers are looking at appropriate transportation methods. The dramatic and fast-paced change from the U.S. being an energy importer to an energy exporter has meant that transport infrastructure is still catching up. Hence, Kinder Morgan's Freedom Pipeline Project was proposed to transport this crude from Texas to California. However, as the industry continued to develop, it was deemed faster and more flexible to freight the crude by rail rather than wait for the new pipeline.[44] The Freedom Pipeline Project is currently on

[44] Lefebvre, B. Kinder Morgan Freedom Pipeline. *Wall Street Journal*. 2013. May 23, 2013. Link.

hold, but is still attracting interest as the industry continues to adapt, evolve, and further develop.

5.2 Pipeline System Flows

There are effectively no pipeline flows of crude oil in Arizona given the limited production and lack of refining capacity in the State.

Petroleum product consumption in Arizona is supplied by two pipelines, both of which are owned and operated by Kinder Morgan and converge in Phoenix. From Wilmington, California, the 20-inch "West Line" enters Arizona in the Yuma area and then flows towards Phoenix where products are stored before distribution and consumption. It has a capacity of 204,000 barrels per day.[45] The "East Line" which is composed of two parallel pipelines (16-inch and 12-inch) that originate in El Paso, Texas. It enters Arizona in the San Simon area and heads to Tucson before turning north-west to reach Phoenix, and has a capacity of over 200,000 barrels per day.[46] The Phoenix terminal can also be supplied by a rail offloading facility. About 260,000 to 270,000 barrels per day have to be delivered to Arizona to maintain stock levels.[47]

Most of the gas consumed in Arizona relies on deliveries which are made via one of the ten interstate gas pipelines. Most of the demand for natural gas is supplied through the interstate pipeline network operated by El Paso Natural Gas (Kinder Morgan), Transwestern Pipeline Company and Questar's Southern Trails. According to the EIA, net receipts of natural gas were 333,353 mcf in 2013. [48] These volumes essentially flowed from the Permian Basin (Texas and New Mexico). But total volumes carried in Arizona's gas pipeline network are much higher, notably because over 900,000 mcf of gas transits from New Mexico/Texas to California.

Natural gas is also extensively used in power production in Arizona. In 2013, the EIA reports that 65 percent of gas consumption in Arizona was used to produce electricity. Major players of the electric power generation sector in Arizona include Arizona Public Service, Arizona Electric Power Cooperative and Tucson Electric Power. Residential and commercial sectors consume much of the remaining share at 13 percent and 10 percent, respectively.

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[45] *(PRN) Kinder Morgan's $210 Million East Line Expansion Complete and in Service - More Fuel for Arizona*. Chron, 2006. Link.
[46] *East Line*. Kinder Morgan. Link.
[47] Based on estimated annual consumption and average monthly sales by year.
[48] *Natural Gas Annual Respondent Query System*. Energy Information Administration. Link.

5.3 Pipeline System Performance

5.3.1 Key Performance Measures

Because pipelines are controlled by private businesses, information on their performance is difficult to ascertain. Although consultations may result in anecdotal information on performance measures, there are no independent data to validate this information. For this reason pipeline performance metrics are not reported on in this document.

5.3.2 Safety and Incidents

In early February 2011, Arizona experienced outages for natural gas and electricity. In the widespread cold temperatures, approximately 18,000 natural gas customers in southern Arizona were affected. The outage was related to the record low temperatures, which led to a temporary loss in natural gas production. The increased demand for natural gas for heating and electricity generation during this time further exacerbated the problem. In the aftermath of the outage, natural gas storage projects were brought to the public's attention as a way to increase gas pipeline reliability.

In 2003, one of the SFPP pipelines ruptured in a residential area of Tucson, spilling over 10,000 gallons of unleaded gasoline. The spill resulted in $14.9 million worth of property damage and also caused major gasoline shortages and price increases in the state.[49] This rupture is believed to have been caused by stress corrosion cracking.

5.3.3 Capacity

A number of factors specific to Arizona will mean that its oil and gas pipeline infrastructure, including distribution and storage, will be developed or upgraded to match the future demands of the state. These factors include:

- Forecast population growth—Arizona's population is forecast to grow to over ten million by 2040[50]
- Increased use of natural gas to generate electricity and the trend to phase out coal-fired power stations. It should be noted that this trend will reduce rail transfers of coal also.
- Increased demand for petroleum products, such as gasoline and diesel for transport use.
- Heightened interest in system redundancy, security, and reliability.

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[49] *Arizona Significant Incidents Listing,* Pipeline and Hazardous Material Safety Administration.
[50] Arizona Department of Administration, Office of Employment & Population Statistics. 2012.

In 2006 and 2007, Kinder Morgan completed expansion and upgrade projects to the East Line, largely as a result of a pipeline rupture that impacted Arizona fuel supplies in 2003. This increased pipeline capacity to over 200,000 barrels per day.

5.3.4 Pipeline Policy and Regulatory Issues

Pipeline networks operate in the private sector, yet safety oversight of the pipeline network is provided by the Pipeline Safety and Hazardous Materials Safety Administration, while the Federal Energy Regulatory Commission (FERC) regulates the interstate transmission of natural gas and oil. This also includes the establishment of reasonable rates for transporting petroleum and petroleum products by pipeline.

Pipeline operators plan, build and operate pipelines and offer capacity to shippers and receivers who use the pipeline. Commitments from shippers are often required long before any new pipeline is constructed. This issue and others, such as the capital costs associated with pipeline development and regulatory approval, all contribute to time and cost implications to deliver new pipeline projects. Where pipeline capacity is not sufficient to match demand, there might be expected to be a shortfall in product availability, often coupled with an increase in prices.

While pipelines are often the only cost effective way of transporting natural gas to market, with refined products such as gasoline, jet fuel and diesel this is not always the case. Many of the bulk fuel terminals in Arizona are supplied by rail. While the operational costs of rail movement are typically higher than for transportation by pipeline, the flexibility of rail movement can offset the additional cost.

6 Border Infrastructure and International Trade Gateways

Key Messages

Truck is the predominant mode for border crossing freight movements between Arizona and Sonora, but Arizona is more reliant on rail on average compared to other southern border states.

Land-based border flows are heavily concentrated in two border crossings:

- Over 85 percent of exports and 88 percent imports from or to Arizona use the Nogales-Nogales border crossing.
- Over ten percent of exports and imports from or to Arizona uses the Douglas-Agua Prieta border crossing.

Recent improvements to Land Ports of Entry in the region have reduced congestion; however, stakeholders expect continued growth in border volumes, suggesting the need for continued planning and investment in border infrastructure.

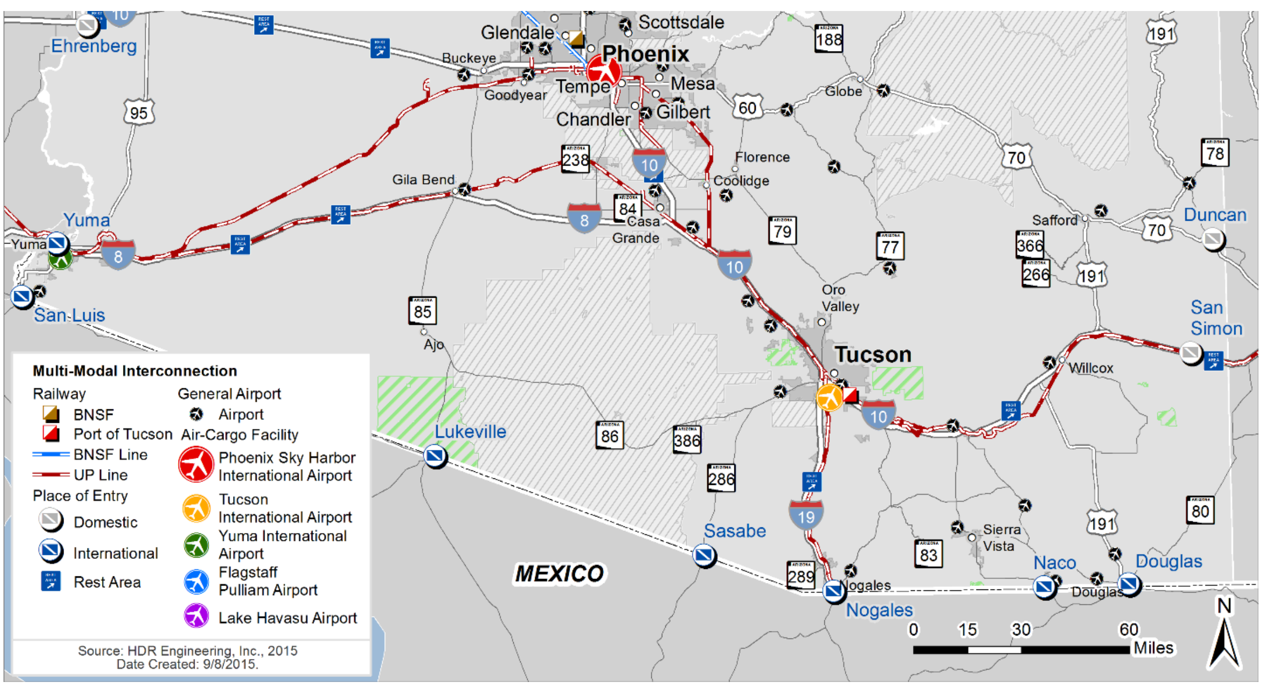
6.1 Arizona's International Gateway Assets

Arizona and the state of Sonora, Mexico share approximately 360 miles of international border. There are six border crossing locations along Arizona's border with Mexico (Figure 37 shows these international Ports of Entry). Each location is identified with the name of the population center in the United States, followed by the name of the population center in Mexico:

- San Luis-San Luis Rio Colorado (westernmost border crossing point)
- Lukeville-Sonoyta
- Sasabe-El Sasabe
- Nogales-Nogales (i.e. Ambos Nogales)
- Naco-Naco
- Douglas-Agua Prieta (easternmost border crossing point)

These six locations are the gateways through which land-based travel and tourism as well as international trade between Arizona and Mexico occur. It is important for these locations to feature competitive gateways to facilitate the movement of goods and to help generate the economic output that can improve the living conditions of residents of the border areas.

Figure 37: Border Crossing Locations on the Arizona-Sonora Border



During 2014, more than $437 billion worth of goods moved through the U.S.-Mexico border using land transportation modes (truck, rail and pipeline). Of this value, $359 billion, or 82 percent, corresponded to goods moved by truck. The land ports of entry (LPOEs) in Arizona processed approximately $30 billion, or 7 percent of the total goods that traveled between the U.S. and Mexico using land transportation modes. Of the $30 billion processed by Arizona border crossings, approximately $20 billion (or two-thirds) crossed the border by truck, $10 billion crossed by rail and a negligible amount was moved by pipeline.[51] Figure 38 displays the distribution of total trade by mode for the US-Mexico border. The numbers correspond to trade moving through LPOEs, using the designated mode to cross the border. A greater percentage of volume/value arrives in Arizona by rail than other southern border states, but trucking still comprises the largest portion of trade.

Figure 38: 2014 Total Land Based US-Mexico Border Trade

	Arizona		New Mexico	
Mode	Total (Thousands)	Modal Distribution	Total (Thousands)	Modal Distribution
Truck	$20,034,830	66%	$18,998,593	100%
Rail	$10,043,347	33%	$4,530	0%
Pipeline	$234,158	1%	$0	0%
Total	$30,312,335	100%	$19,003,123	100%
Mode	Texas		California	
Truck	$266,149,164	80%	$53,852,154	99%
Rail	$63,057,885	19%	$427,109	1%
Pipeline	$4,435,782	1%	$317,346	1%
Total	$333,642,831	100%	$54,596,609	100%
Mode	US Southern Border Total			
	Total (Thousands)		Modal Distribution	
Truck	$359,038,740		82%	
Rail	$73,532,871		17%	
Pipeline	$4,987,286		1%	
Total	$437,554,898		100%	

Source: CPCS Analysis of Bureau of Transportation Statistics, North American Transborder Freight Data Set.

Beyond the total value of goods processed at Arizona border crossings, a crucial statistic for strategic investment in border infrastructure is the value of Arizona's imports and exports using Arizona's LPOEs. Figure 39 displays the types of movements and their portions relative to all land based US-Mexico trade using Arizona's LPOEs. Arizona exports more than it imports from Mexico when measuring based on value, but the vast majority of shipments are traveling through Arizona.

[51] *North American Transborder Freight Data Set.* Bureau of Transportation Statistics. Link.

Figure 39: 2014 Total Land Based US-Mexico Trade by Movement Type

Major Contributing Factor	Major Contributing Factor	Major Contributing Factor
Traveled Through Arizona	$17,724,606	58%
Exported from Arizona	$7,049,307	23%
Imported to Arizona	$5,538,421	18%
Total	$30,312,334	100%

Source: CPCS Analysis of Bureau of Transportation Statistics, North American Transborder Freight Data Set.

On an individual port level, over 85 percent of exports and 88 percent imports from or to Arizona use the Nogales-Nogales border crossing. Additionally, Nogales-Nogales and Douglas-Agua Prieta, account for over 96 percent of all imports and exports from or to Arizona. Clearly Nogales-Nogales and to a lesser extent Douglas-Agua Prieta are critical for the movement of Arizona's exports and imports. San Luis-San Luis Rio Colorado comprises about three percent of exports and one percent of imports, with the remainder of LPOE's having smaller import and export values.

6.1.1 Overview of Border Crossing Characteristics

Arizona's six border crossing locations are host to nine LPOEs. The border crossing location of San Luis-San Luis Rio Colorado features two LPOEs while the location of Nogales-Nogales features three LPOEs.

There are four types of flows that LPOEs on the Arizona-Sonora border may process: pedestrians, passenger vehicles, commercial vehicles, and rail. The type of flow processed by a specific LPOE depends on the infrastructure and staffing characteristics of each entry point. The complete list of LPOEs located in the Arizona-Sonora border, along with their location and the type of flows processed, is provided in Figure 40.

Figure 40: Land Ports of Entry in Arizona

LPOE	Border Crossing Location	Type of Flows Processed
San Luis I	San Luis, Arizona	Passenger vehicles and pedestrians
San Luis II	San Luis, Arizona	Commercial vehicles
Lukeville	Lukeville, Arizona	Commercial vehicles, passenger vehicles, and pedestrians
Sasabe	Sasabe, Arizona	Commercial vehicles, passenger vehicles, and pedestrians
Mariposa	Nogales, Arizona	Commercial vehicles, passenger vehicles, and pedestrians
DeConcini	Nogales, Arizona	Passenger vehicles, pedestrians, and rail
Morley Gate	Nogales, Arizona	Pedestrians
Naco	Naco, Arizona	Commercial vehicles, passenger vehicles, and pedestrians

Douglas	Douglas, Arizona	Commercial vehicles, passenger vehicles, and pedestrians

Source: Arizona-Sonora Border Master Plan

Given the distance between the different LPOEs in the Arizona-Sonora border region, most of these facilities process passenger vehicle, commercial vehicle and pedestrian flows. It must be noted that San Luis-San Luis Rio Colorado and Nogales-Nogales, by virtue of having more than one LPOE, are able to separate different types of flows into different LPOEs. Finally, the only LPOE that processes rail cargo is DeConcini, located in Nogales, Arizona. Historically, Naco and Douglas LPOEs had railroad crossings, but were abandoned leaving Nogales as Arizona's only LPOE with a railroad crossing.

Nogales Border Crossing

The Nogales border crossing is a critical piece of Arizona's infrastructure. The Nogales-Nogales border crossing is comprised of three LPOEs: Mariposa, DeConcini and Morley Gate. Mariposa and DeConcini are the two most critical for freight, as Morley Gate is pedestrian-only. The following statistics display the importance of Nogales-Nogales to Arizona and the US:[52]

- Most active land port in Arizona
  - 82 percent of Arizona's northbound truck crossings in 2014
  - 87 percent of Arizona's northbound loaded truck containers in 2014
  - 85 percent (value) of Arizona's exports in 2014
  - 88 percent (value) of Arizona's imports in 2014
- Only train crossing in Arizona
  - 795 northbound trains in 2014
  - 42,802 northbound loaded rail cars in 2014
- Main entry point for fresh produce entering from Mexico for the West Coast
- Fourth busiest land port of entry into the United States

As the major player in terms of crossings, total value and the only train-accessible border crossing, the Nogales-Nogales crossing is a key component of Arizona's freight infrastructure.

6.1.2 Key Border Crossing Facilities

The nine LPOEs described in the previous section have different characteristics based on their geographic location and the types of volumes they process. A brief description of the

[52] *North American Transborder Freight Data Set.* Bureau of Transportation Statistics.

main characteristics of each LPOE is provided below, paying particular attention to the connectivity of these LPOEs and to the freight characteristics of each LPOE.

Figure 41: Characteristics of Land Ports of Entry

LPOE	Key Characteristics
San Luis I	• Inspects passenger vehicles and pedestrians • Located at the City of San Luis (U.S.) • Daily access for passenger vehicles via six general lanes and two SENTRI Lanes • Also processes pedestrians via general lanes and one SENTRI lane • Connects U.S. Route 95 with Mexico's Federal Highway 2 and Sonora's State Highway 40
San Luis II	• Inspects commercial vehicles • Expansion of the San Luis I LPOE into an 80-acre commercial vehicle LPOE • Located five miles east of the San Luis I LPOE. • Commercial vehicles are processed through four primary inspection lanes. LPOE also supports the Free and Secure Trade (FAST) traffic program with a dedicated northbound FAST lane • Connects I-8 and SR 195 Surface Area Highway with Mexico's Federal Highway 2
Lukeville	• Inspects commercial vehicles, passenger vehicles, and pedestrians • Built more than 30 years ago to process tourism traffic between Arizona and Puerto Peñasco (Rocky Point) in Sonora • Primary inspection facilities include five passenger vehicle lanes, including one READY Lane (for pre-approved radio-frequency identification), one Pedestrian Gate and one Commercial lane • Connects SR 85 with Mexico's Federal Highways 2 and 8
Sasabe	• Inspects commercial vehicles, passenger vehicles, and pedestrians • Opened in 1916 and was modernized in the 1990s • Roughly halfway between the Nogales LPOE and the Lukeville LPOE • One lane processes all northbound traffic • Connects SR 286 with an unpaved road on the Mexican side
Mariposa	• Inspects commercial vehicles, passenger vehicles, and pedestrians • Opened for commercial traffic in 1976, expanded to handle passenger vehicles in 1983 and expanded again in 2014 to relieve congestion and reduce wait times • Principal gateway for international trade in Arizona • Part of CANAMEX corridor, linking Mexico City, Mexico to Edmonton, Canada • Links SR 189 (Mariposa Road) with Mexico's Federal Highway 15
DeConcini	• Inspects rail, passenger vehicles, and pedestrians • Created over 100 years ago, modernized in 1994 and renovated in 2012 • Arizona's only rail processing LPOE (links the UPRR and Ferromex railroads) • Rail line intersects multiple city streets contributing to congestion and limiting to five mph • Due to spatial constraints, train processing occurs 7.5 miles north in Rio Rico, Arizona where inspections require a minimum of two hours • Links I-19 (Grand Avenue) with Mexico's Federal Highway 15
Morley Gate	• Inspects pedestrians • Extension of the DeConcini LPOE • Four station pedestrian crossing

LPOE	Key Characteristics
	• Pedestrian Re-Engineering study is complete and construction drawings are in process • Links Morley Avenue with Mexico's Federal Highway 15 via Calle Elías
Naco	• Inspects commercial vehicles, passenger vehicles, and pedestrians • Designed and constructed in 1936 and modernized in 1994 • Provides daily access for passenger vehicles via two general lanes • There is one lane for processing all southbound traffic • Links SR 80 and SR 92 with Mexico's Federal Highways 2 and 17
Douglas	• Inspects commercial vehicles, passenger vehicles, and pedestrians • Built in 1933 and renovated in 1993 • Commercial vehicle processing includes three primary inspection lanes and 20 designated docks • Use of primary and secondary inspection facilities is limited by the turning radius entering the cargo area from Mexico and a lack of parking. • Links SR 80 and U.S. Route 191 with Mexico's Federal Highways 2 and 17

6.2 Border Crossing Flows

In 2014 more than 5.4 million trucks and more than 10,400 trains crossed the U.S.-Mexico border in the northbound direction. Of the northbound trucks,[53] more than 3.7 million crossed through LPOEs in Texas, more than 1.1 million through LPOEs in California, almost 400,000 through LPOEs in Arizona, and approximately 100,000 through LPOEs located in New Mexico. The number of trucks crossing through the LPOEs in Arizona represents approximately 7.3 percent of the total trucks that crossed the U.S.-Mexico border last year. This share is the second lowest for Arizona since 1995.

Regarding rail crossings, during 2014 almost 800 trains crossed in the northbound direction using LPOEs in Arizona, capturing 9.2 percent of all the northbound rail crossings between the United States and Mexico. In contrast to the case of trucks, this share represents the third largest year since 1995 for LPOEs in Arizona.

In 2014 approximately 82 percent of all truck crossings and 100 percent of all rail crossings between Arizona and Mexico occurred through Nogales.

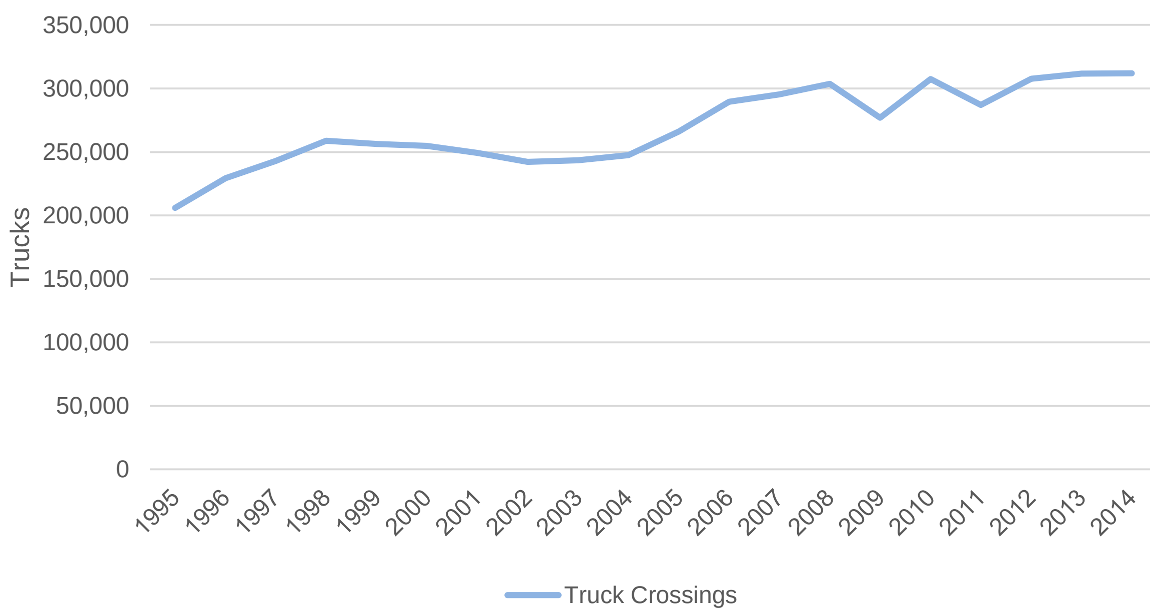
The majority of northbound border crossings from Sonora into Arizona occur through the three LPOEs in Nogales.[54] In 2014 approximately 46 percent of all pedestrian crossings, 39

[53] US Customs and Border Patrol do not collect data on the number of outbound border crossings.
[54] The data collected by BTS aggregates data by border crossing location (not by individual LPOE) and therefore data on all three LPOEs in Nogales cannot be further disaggregated.

percent of passenger vehicles, 82 percent of all truck crossings, and 100 percent of all rail crossings through LPOEs in Arizona occur through the Nogales LPOEs. Figure 42 and Figure 43 present the total number of crossings at the Nogales LPOEs for truck and rail as well as the proportion of State crossings they represent for these modes. The San Luis LPOEs near Yuma experienced the second highest number of border crossings in all three categories.

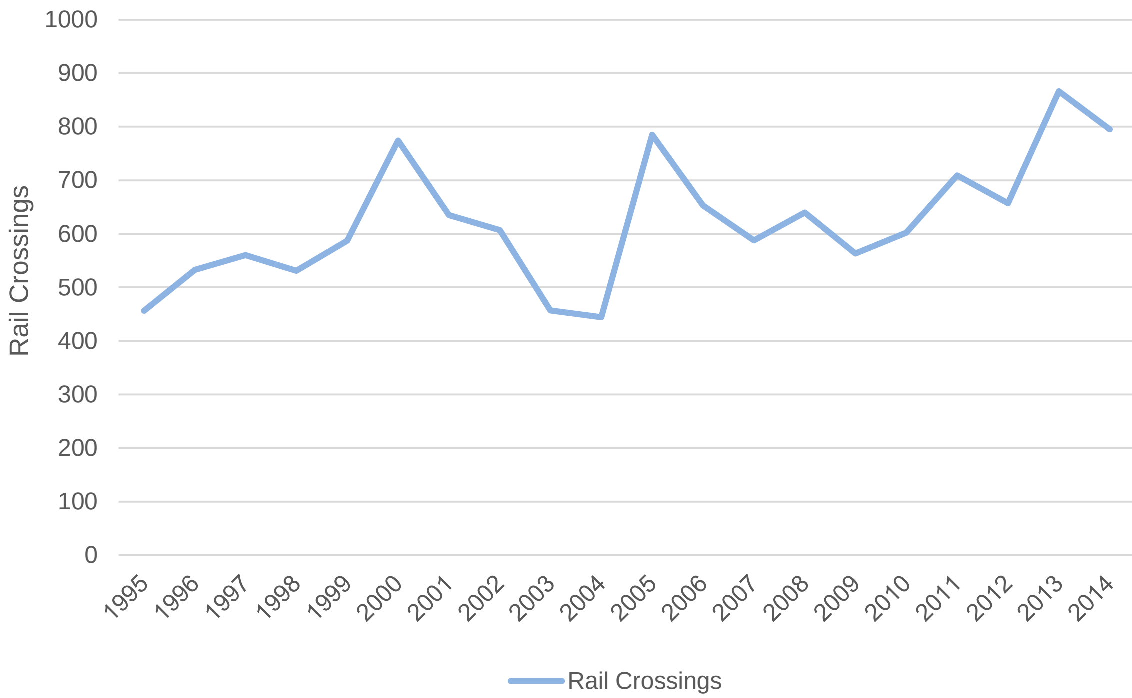
The two types of flows that have a direct impact on freight planning are the commercial vehicles volumes and the rail volumes across the Arizona-Sonora border. Therefore, these flows are analyzed in more detail in the remainder of this section.

Figure 42: Number of Northbound Trucks Crossing through Nogales LPOEs



Source: USDOT/RITA/BTS

Figure 43: Number of Northbound Rail Crossings through Nogales LPOEs



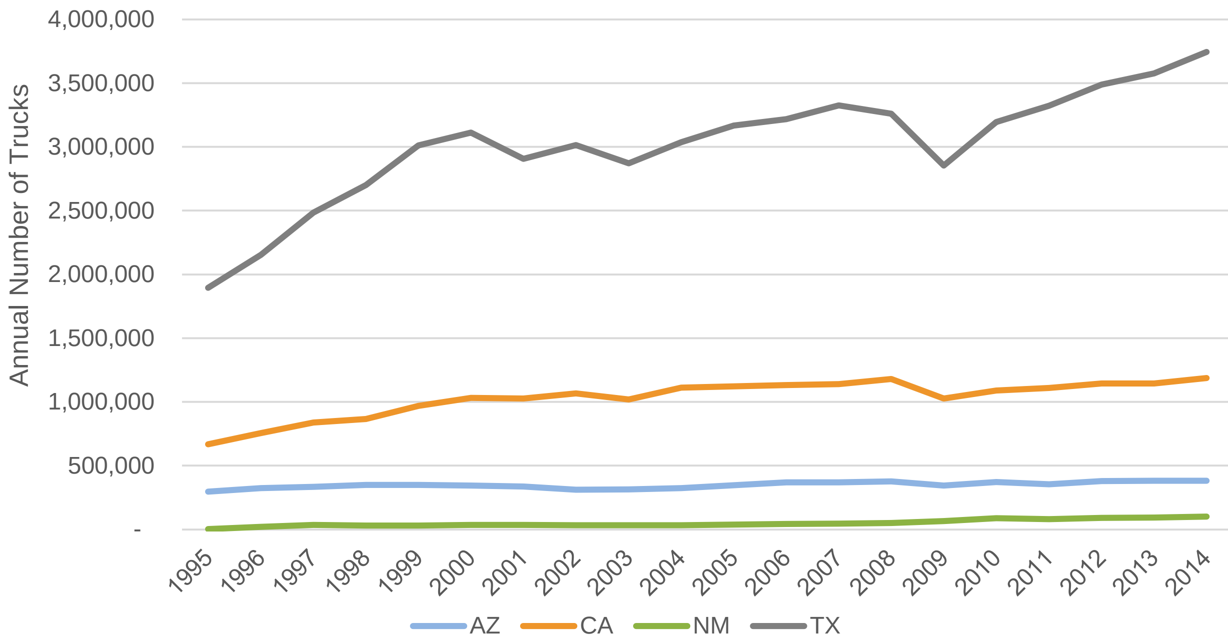
Source: USDOT/RITA/BTS

Commercial Vehicle Volumes

More than 380,000 northbound commercial vehicles (trucks) crossed the U.S.-Mexico border using and Arizona LPOE during 2014. The overall number of trucks crossing using LPOEs in Arizona has shown little increase relative to Texas and California which have grown steadily after 2009. Moreover, the increase in truck volume at Arizona LPOEs from 1995 to 2014 is the lowest across all the southern border crossing states with only 28 percent growth. In comparison, the volumes of trucks grew by 98 percent in Texas, by 78 percent in California and by 4,050 percent in New Mexico during that same period[55] (Figure 44).

[55] The larges growth of truck volumes at New Mexico's LPOEs can be attributed to the opening of the Santa Teresa border crossing in 1996

Figure 44: Number of Northbound Trucks Crossing the U.S.-Mexico Border, by State



Source: USDOT/RITA/BTS

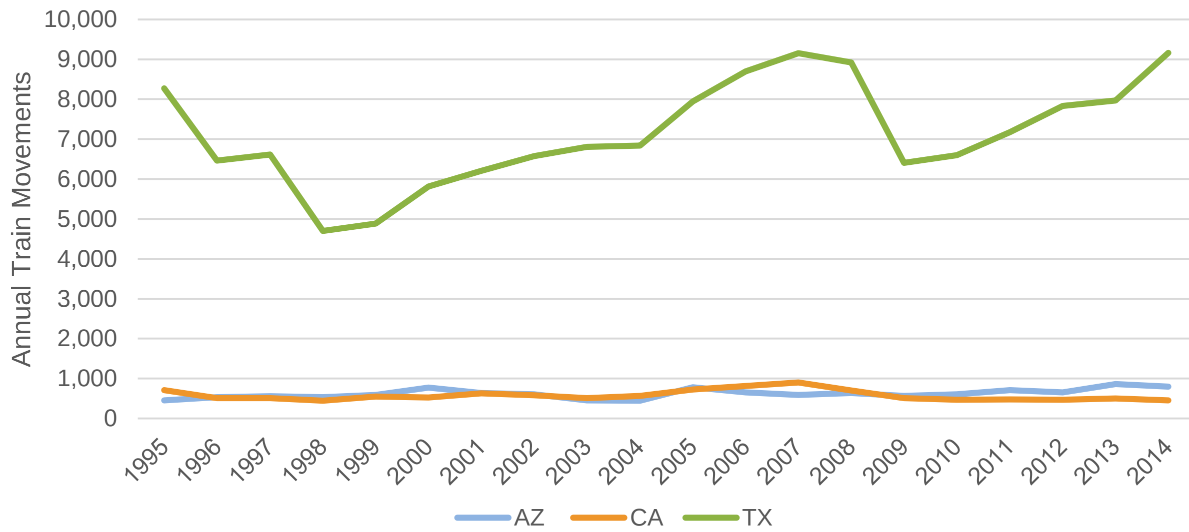
Nogales continues to be the border crossing location of choice for trucks entering the United States through Arizona LPOEs. The Mariposa LPOE (which is the only LPOE in Nogales that processes commercial vehicles) handles approximately 82 percent of all the truck crossings in the LPOEs of the state. With the exception of the Mariposa LPOE[56] the number of border crossing trucks recorded in all other LPOEs in Arizona was lower in 2014 than in 1995.

Rail Volumes

Between 1995 and 2014, the number of trains crossing northbound into the United States through the Arizona LPOEs has grown by 74 percent. The number of trains crossing through California has declined by 35 percent and the crossings through Texas have grown by 11 percent (Figure 45).

[56] In Mariposa, total truck volumes have grown 51 percent since 1995.

Figure 45: Number of Northbound Trains Crossing the U.S.-Mexico Border, by State



Source: USDOT/RITA/BTS

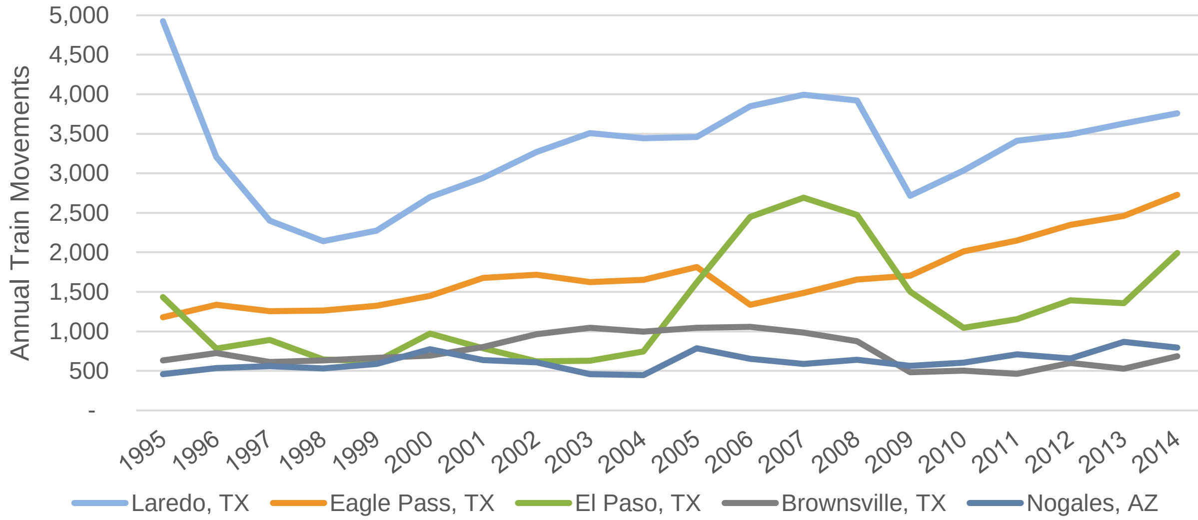
Arizona experienced the peak number of trains in 2013 with 866 (2014 was down to 795), while Texas handled the highest number of trains per year (9,161) in 2014. California's peak train year was 2007 with 905 trains.

Figure 46 further disaggregates northbound train crossings by border crossing. As of 2014, only seven border crossings had northbound train crossings, with the top five collectively accounting for almost 96 percent of all crossings.[57] Overall, the majority of northbound train crossings occur at the Texas LPOEs of Laredo, Eagle Pass and El Paso, collectively comprising over 81 percent of train crossings in 2014.

In terms of the share of the total northbound train crossings over the past five years, Laredo has lost market share dropping from 40 percent of total train crossings in 2010 to 36 percent in 2014. El Paso captured the majority of Laredo's share increasing from 14 percent to 19 percent, while Eagle Pass, Brownsville and Nogales remained relatively stable.

[57] Calexico East, California and Otay Mesa, California are the remaining two border crossings that reported northbound train crossings in 2014, collectively comprising 4.4 percent of northbound train crossings along the southern border.

Figure 46: Number of Northbound Trains Crossing the U.S.-Mexico Border, by LPOE



Source: USDOT/RITA/BTS

Between 1996 and 2014, the number of trains crossing into the United States through Nogales increased by 49 percent; however, the number of loaded rail cars grew by 219 percent during this same period. Trains crossing through Nogales are not only increasing in number, they are also becoming larger: the average number of loaded rail cars per train in 1996 was 25, but by 2014 this number increased to 53 (Figure 47).

Figure 47: Number of Northbound Trains and Loaded Rail Cars Crossing the U.S.-Mexico Border in Nogales

Source: USDOT/RITA/BTS

6.3 Border Crossing Performance

Several factors contribute to the performance of a LPOE, such as facility design, the number of lanes and inspection booths, the schedule and the efficiency of LPOE staff, and population centers near the LPOE (affects the type of goods and volumes served by LPOE). Therefore, it is impossible to define a single indicator that measures the performance of an individual LPOE. This section then proposes a series of indicators that, when analyzed in conjunction, provide a good indication of the performance of a LPOE facility.

6.3.1 Key Performance Measures

There are several key performance measures that can be assessed to determine how well border crossing infrastructure on the Arizona-Sonora border region facilitates goods movement and economic output. These measures can be categorized into "absolute" and "relative" measures.

- **Absolute Measures** – are defined as those that can be measured directly at the specific LPOEs and are directly linked to individual characteristics of each LPOE.
- **Relative Measures** – are observed at each individual LPOE, but are linked to characteristics of other LPOEs in the larger U.S.-Mexico border region.

The two key "absolute" performance measures for LPOEs are listed in Figure 48, along with potential sources where this data can be found.

Figure 48: Absolute Border Performance Measures

Border Performance Measure	Source
Wait times at individual LPOEs for the different types of traffic that cross the border	Collected by LPOE stakeholders, CBP
Total number of crossings, by type of traffic, at individual LPOEs	BTS

Absolute Border Performance Measures

The first "absolute" measure, wait times at the LPOE, is the most accurate way to link an indicator of performance to operational characteristics and actions embedded in each individual LPOE. The wait times are a result of several LPOE-specific characteristics that include the design of the LPOE, the capacity of the facility, the processing time required by CBP officials to inspect different types of traffic and the demand for the facility.

Commonly, accurate measures of wait times for different traffic types at individual LPOEs are not readily available unless a specific effort is being conducted by stakeholder groups to collect this kind of data. An approximation of this measure is published by CBP, which lists real-time estimations of wait times at each LPOE for different traffic types. However, the accuracy of these wait time estimates has been criticized by practitioners due to CBP's unconventional way to estimate wait time.[58] Additionally, wait time data are not compiled into a proper database that is available to the public.

The second "absolute" measure, total number of crossings by traffic type, is the result of the equilibrium between the "bundled" needs by users of border crossing infrastructure (in terms of schedule of operation, type of traffic processed, wait times, etc.) and the "bundled" operational indicators exhibited by each LPOE.

Relative Border Performance Measures

In addition to the "absolute" performance measures listed above, two key "relative" performance measures are listed in Figure 49, along with potential sources where the information to build these indicators can be found.

Figure 49: Relative Border Performance Measures

Border Performance Measure	Source
Share of number of crossings at LPOE with respect to total border crossings, by traffic type	BTS
Share of value of goods transported at LPOE with respect to total value of goods transported across the border, by traffic type	BTS

These two indicators are relative in the sense that the resulting measure depends not only on the performance of the LPOE analyzed, but also on the performance of and actions taken at other LPOEs. For example, an increase in the share of the number of truck crossings at a particular LPOE may be the result of either improved performance by the LPOE analyzed (for example, by reducing wait times due to more efficient inspections) or a decrease in performance by a LPOE that competes for the truck traffic (for example, lane closures due to maintenance).

The second measure, related to the share of the value of goods transported, should illustrate changes in performance by geographically close LPOEs that compete for the same types of traffic. The reason is that for LPOEs that compete for similar type of traffic, changes in performance metrics are more likely to trigger changes to LPOE choices for those goods whose value is high or which are time-sensitive.

6.3.2 Infrastructure Conditions

With the exception of Nogales LPOEs, original construction of most Arizona LPOEs occurred in the 1930s and modernization of some LPOEs occurred in the 1990s. San Luis, Nogales

[58] CBP estimates wait times based on a visual inspection of the queues leading to the US primary inspection booths, ignoring in many cases the queues that take place on the Mexican side of the border.

Mariposa, and Lukeville LPOEs have been recently or are currently being reconfigured and/or expanded to improve traffic flow and to decrease wait times.

6.3.3 Capacity

As mentioned before, the majority of the freight-related border crossings in the northbound direction for the State of Arizona occur at the Nogales-Nogales location. In particular, the Mariposa LPOE handles the majority of truck crossings in the state and the DeConcini LPOE handles all rail crossings.

Information collected from local stakeholders suggests the growth of trade will continue in the Arizona-Sonora border region due to the favorable economic conditions in Mexico, with clusters such as aerospace leading the way. Therefore, the capacity of the region's LPOEs capacity is anticipated to be put to the test in the next few years.

A brief summary of different capacity-related measures (such as processing volumes per day, operation schedule, number of lanes and availability of trusted traveler program facilities) is reported in Figure 50.

Figure 50: Capacity-Related Measures

LPOE	Original Design Capacity	Commercial Processing Windows	Commercial Lanes	FAST Lanes
Mariposa	400 trucks per day (currently processing 1,000 trucks per day on average)	8 a.m.–9 p.m., Monday–Saturday	Eight primary inspection lanes	Y
San Luis II	New facility recently completed – initial design 150 trucks per day, potential to expand to 650 trucks by 2030	Peak produce season: 9 a.m.–8 p.m., Monday– Saturday Off-peak season: 9 a.m.–6 p.m., Monday–Saturday	Three primary inspection lanes	N
Douglas	Unknown	9 a.m.–6 p.m., Monday–Friday, Noon–2 p.m. Saturday	Three lanes, but only one used due to geometry of the site and vehicle turning radii	N
Naco	Unknown	9 a.m.–5 p.m., Monday–Friday	One	N
Lukeville	Unknown	8 a.m.–4 p.m., Monday–Saturday	One	N
Sasabe	Unknown	8 a.m.–8 p.m., Seven days per week	No dedicated lane	N

The Mariposa LPOE is currently operating, on average, at more than twice its original capacity for commercial vehicles. The recent improvements to this LPOE are anticipated to eliminate some of the pressure on this infrastructure. However, these improvements are unlikely to represent a long-term solution for the growth of border crossing traffic in the Nogales-Nogales location.

6.3.4 Fluidity

The advent of the North American Free Trade Agreement (NAFTA) has generated a large increase in demand for the use of LPOE infrastructure along the U.S.-Mexico border. In particular, since 1995 the total value of trade moving through the LPOEs on the southern border has increased by almost 380 percent, while the number of trucks crossing the border in the northbound direction has almost doubled during that same period. As mentioned before, local stakeholders expect this growth to continue in the future, putting more pressure on the capacity of the LPOEs in the region.

This mismatch of rapidly-increasing demand and slow-increasing LPOE capacity has generated a significant growth in wait times at the LPOEs in the entire border region. In the case of the Arizona-Sonora LPOEs, this is especially true during the peak produce season. Peak produce season takes an already high level of demand for LPOE use and adds large spikes in the demand due to the need for perishable goods to cross the border in the quickest way possible.

Furthermore, local stakeholders identify the LPOEs and their adjacent road network as the main bottleneck for the increase of trade volume through the region. In particular, they cite poor road infrastructure to and from the LPOEs, lack of efficiency in customs and inspection processes at the LPOEs, and high levels of utilization of existing capacity as the main contributing factors for high border crossing wait times along the Arizona-Sonora LPOEs.

When available, we will use ATRI data to identify and quantify the severity of specific bottlenecks at different border locations and LPOEs. However, a review of the literature has allowed us to identify some of the main issues at specific border crossing points. A brief summary of those findings is presented below, by major LPOEs significant to freight flow.

Mariposa LPOE

Originally designed to handle 400 trucks daily, the Mariposa LPOE now processes up to 1,500 trucks each day during the winter peak produce season.[59] The number of northbound commercial truck crossings exceeded 312,000 in 2014 making Mariposa the busiest LPOE in Arizona (about 1,000 per day given Mariposa is only open six days a week).[60]

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[59] *Arizona-Sonora Border Master Plan.* Arizona Department of Transportation. Link.
[60] *North American Transborder Freight Data Set.* Bureau of Transportation Statistics.

Commercial vehicle wait times are seasonal, ranging between a maximum of eight hours during the peak produce season (October-May) and two to four hours during the rest of the year. Lengthy wait times can negatively affect the quality of the produce.[61]

Douglas LPOE

Over 33,000 northbound commercial trucks or about 106 trucks per day crossed into the U.S. using the Douglas LPOE in 2014. Using 2014 truck counts, the Douglas LPOE had the second greatest truck traffic of all Arizona LPOEs.[62] Both Mariposa and Douglas are open six days a week, but Douglas is open fewer hours than Mariposa.

Several safety issues have been identified with the traffic flows and congestion at the current Douglas LPOE. A project, currently awaiting funding, was studied to address these and other safety concerns. When funded, the project may result in the creation of a new commercial inspection compound on approximately 28 acres to be acquired west of the existing LPOE. The new facility will provide for separate circulation and inspection of inbound and outbound trucks. There will be 20 import inspection bays and 2 export bays.[63]

When the new commercial inspection compound is funded and complete, the existing facility will be expanded and reconfigured to provide new passenger vehicles and bus inspection facilities.

Expansion of the existing Mexican inspection facility and associated transportation infrastructure in neighboring Agua Prieta is necessary in order for the planned design of the expanded LPOE to function as intended.

San Luis II LPOE

The San Luis II was opened in October 2010 and was constructed to relieve congestion at San Luis I by inspecting commercial vehicles. San Luis II was expected to process approximately 150 trucks per day with the potential to increase capacity to 650 trucks per day by 2030.[64] The San Luis II LPOE processes almost 32,000 northbound trucks or about 102 trucks per day in 2014. Based on 2014 trucking data, San Luis II is the third largest LPOE in Arizona. [65]

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[61] *Arizona-Sonora Border Master Plan.* Arizona Department of Transportation.
[62] *North American Transborder Freight Data Set.* Bureau of Transportation Statistics.
[63] *Arizona-Sonora Border Master Plan.* Arizona Department of Transportation.
[64] ibid
[65] *North American Transborder Freight Data Set.* Bureau of Transportation Statistics.

Naco LPOE

The Naco LPOE was originally constructed in 1936 and was modernized in 1994. Naco processed over 3,600 northbound commercial trucks in 2014 or almost 14 per day given it is open five days a week. Overall, Naco has the fourth largest number of northbound commercial trucks.[66] The Arizona-Sonora Border Master Plan found no major deficiencies in Naco's border facilities. Considering both the adequacy of the LPOE and the small amount of truck traffic, the Naco LPOE border facilities are unlikely to change due to trucks.

Lukeville LPOE

The Lukeville LPOE is used by tourists traveling both south and north through to Puerto Peñasco, Mexico (Rocky Point) but serves fewer than 100 trucks per year. During the week, the Lukeville LPOE processes approximately 800 vehicles per day. With increased traffic on holiday weekends, this number soars to over 6,000 vehicles per day and therefore can potentially cause delays to the number of commercial vehicles using this LPOE.[67] A recent series of improvements has slightly reduced the wait times during holidays, but more is needed to address the long-term problem.

Sasabe LPOE

The Sasabe LPOE is primarily a passenger and pedestrian crossing. In 2014 Sasabe reported zero northbound trucks crossings, but does handle a minimal amount of freight transported over the border in containers.[68] In total, the Sasabe LPOE had 239 loaded and 256 empty containers cross the border.[69] The Sasabe LPOE was last modernized in 1990, when the U.S. and Mexico agreed to develop a paved road to Sasabe, but the Mexico side of the border remains unpaved.[70] Overall, the Sasabe LPOE has the smallest amount of traffic using the LPOE including both freight and passenger travel.

6.3.5 Border Crossing Policy and Regulatory Issues

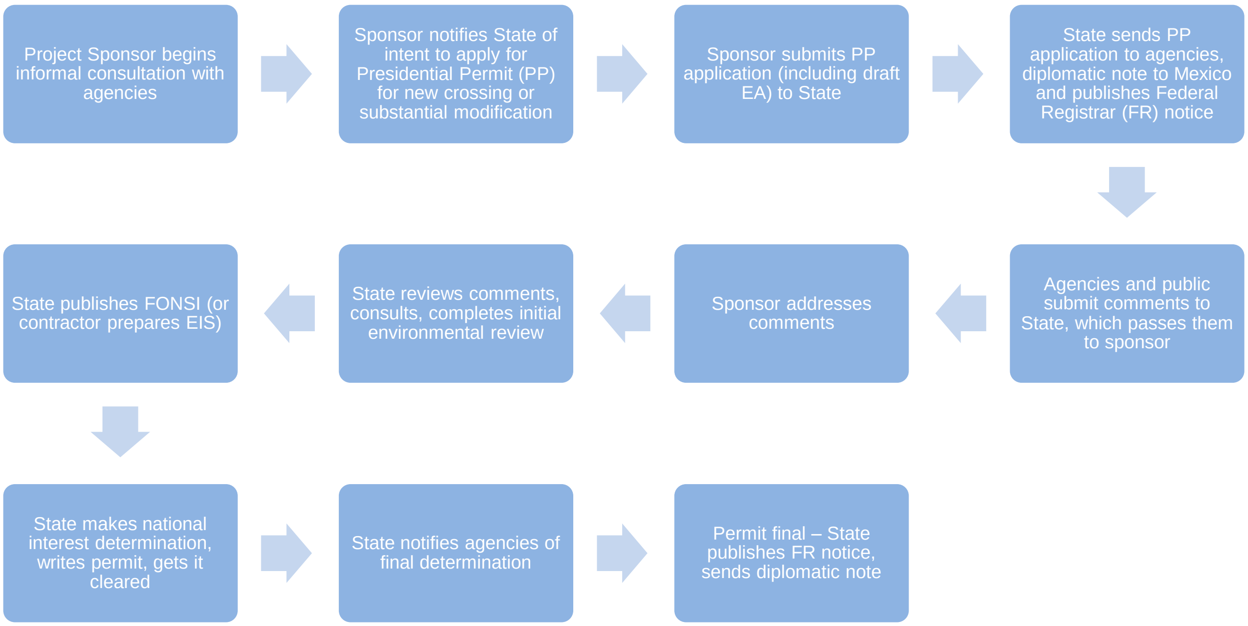
One of the main impediments of timely provision of capacity at the LPOEs in the region is a lack of funding, both on the United States and Mexico side, to develop projects of modernization or expansion.

In addition to this, the multijurisdictional nature of border crossing infrastructure requires that lengthy processes be set in motion when improvements to LPOEs are made. Even when the border location has a Presidential permit for a border crossing entry point, the process requires a number of rounds of discussion between several partnering agencies on

[66] *Arizona-Sonora Border Master Plan.* Arizona Department of Transportation.
[67] ibid
[68] BTS staff suggested that it is likely that truck counts were added to another LPOE due to an issue with data collection.
[69] *North American Transborder Freight Data Set.* Bureau of Transportation Statistics.
[70] *Arizona-Sonora Border Master Plan.* Arizona Department of Transportation.

both sides of the border. The partnering agencies have to reach an agreement not only on the vision of the improved LPOEs but also on the specific characteristics of the infrastructure. In the worst-case scenario, the first step is to apply for a Presidential permit for a new border crossing entry point, which can take several years to secure. A flowchart below showing the Presidential permit process is featured in Figure 51.

Figure 51: Presidential Permit Process



Source: HDR analysis of U.S. Department of State process.

7 Arizona Freight Clusters and Facilities

Key Messages

Freight clusters are concentrations of freight-dependent businesses, often engaged in warehousing or industrial activities and frequently supported by nearby intermodal transfer terminals, airports, or pipeline terminals which facilitate the movement of goods between modes.

In Arizona, the greatest concentration of freight activity is located along the I-10 corridor in Phoenix and Tucson, and includes clusters located at Tolleson, Sky Harbor Airport, Chandler, and the Port of Tucson. Outside the two metropolitan areas, clusters are notably located in Casa Grande, Yuma City, Prescott Valley, Flagstaff, Lake Havasu City, Bullhead City, Sierra Vista and the border city of Nogales.

Arizona's freight clusters and generally well connected to the multimodal transportation system, although some experience congestion and delays.

7.1 Arizona Freight Clusters and Facilities

Freight-dependent businesses tend to cluster together in large and small concentrations near key transportation facilities. This relationship—between freight-intensive land uses and the supporting highways, railways, airports, and pipelines—is a critical component of Arizona's economic competitiveness.

This section introduces—at a statewide level—the major clusters of freight activity and the connectivity between those clusters and key transportation facilities, including the supporting intermodal terminals that facilitate transfers of cargo between modes.

7.1.1 Freight Clusters and Facilities

Freight clusters were identified for warehousing and industrial facilities based on the CB Richards Ellis (CBRE) dataset. The dataset is based on construction permit records from 1998 to 2015. Only the completed projects were considered for cluster mapping. Figure 52 shows the location and density of freight clusters in Arizona using a calculation of square footage of warehousing and industrial facilities per square mile.

Using this methodology, the greatest concentration of warehousing and industrial activities is located in the Phoenix metropolitan area, followed by the cluster in the Tucson metropolitan area (Figure 52). In Phoenix, the clusters are generally located in the southern portion of the metropolitan area concentrated along the I-10 corridor, including Tolleson, around Sky Harbor Airport, in Guadalupe and Chandler, as well as in the northern area in Deer Valley. In Tucson, there are two major clusters – one at the south, near Tucson Airport and including the Port of Tucson, and one at the north close to I-10. Outside the two metropolitan areas, clusters are notably located in Casa Grande, Yuma City,

Tolleson/western Phoenix Cluster

One of the largest freight activity clusters in Arizona is located around Tolleson and western Phoenix—bounded roughly by I-10 on the north, the Salt River on the south, I-17 on the east, and Buckeye on the west.

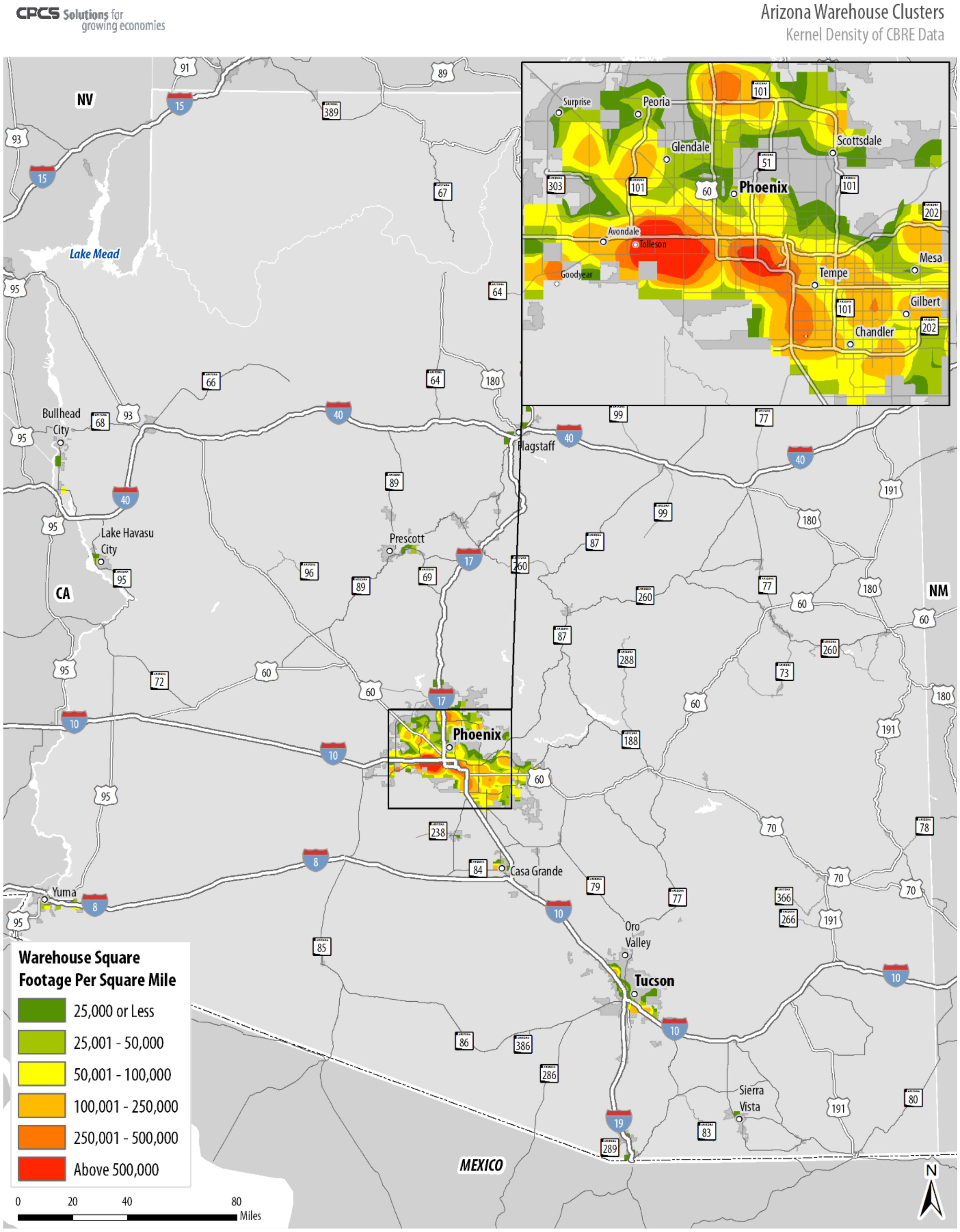
- Freight-dependent businesses in this cluster utilize I-10 and Union Pacific's Phoenix subdivision to access the national network.
- Over 20 Fortune 500 companies maintain a presence in the vicinity, employing more than 20,000 people in distribution, fulfillment, and manufacturing.

Prescott Valley, Flagstaff, Lake Havasu City, Bullhead City, Sierra Vista, and Nogales. The clusters located in Nogales, Yuma, and Sierra Vista support international trade through nearby Ports of Entry, including Arizona's busiest gateway with Mexico, Nogales Mariposa. In addition to border crossing activity, there is significant shipping, warehousing, and commercial activity within the vicinity of these Ports of Entry.

7.1.2 Intermodal and Transload Facilities

Section 3 of this report identifies more than 20 intermodal rail terminals and transload terminals across the state. These facilities are frequently located within or near the warehousing/industrial clusters. Similarly, pipeline terminals and commercial air cargo facilities are also frequently located within the identified clusters, and in some cases—like Sky Harbor Airport—serve as anchors of major clusters.

Figure 52: Warehousing/Industrial Clusters



Source: CPCS Analysis of CB Richard Ellis (CBRE) Dataset

7.2 Connectivity of Freight Clusters and Facilities

Most of Arizona's major freight clusters are located near major highway corridors, such as I-10, I-17, I-8, I-19 and I-40. Exceptions include Prescott, which is connected to the freight corridors by rural arterials SR 69 and SR 89, and Sierra Vista, which is connected to I-10 by Route 90. Most major clusters have railway access, while the major clusters in Phoenix and Tucson are located in close proximity to the airports. The freight corridors are generally congested around the clusters. The clusters located in Phoenix and Tucson are affected by congestion within the urban area, especially on north-south avenues on the western side of Phoenix and in Tolleson that trucks use to access I-10.

A review of the highway performance data presented in Section 2 indicates that trucks accessing all the identified statewide clusters are affected by congestion ranging from moderate to severe. An exception is the Casa Grande cluster. The congestion affecting the clusters is more acute during the morning and evening peak periods with the exception of I-19 near Nogales, where congestion is the worst during the midday period due to border crossing delays. Figure 53 summarizes road performance issue for each of the major freight clusters.

Figure 53: Warehousing/Industrial Clusters and Transportation System Access

Cluster Name	Mode Access	Road Performance Issues
Phoenix	Road, Rail, Air	Peak hour bottleneck on I-10 and I-17
Tucson	Road, Rail, Air	Peak hour bottleneck on I-10 and I-19
Casa Grande	Road, Rail	No bottlenecks on freight corridors
Yuma City	Road, Rail	Peak hour bottleneck on US-95
Prescott	Road*	Peak hour bottleneck on rural arterials SR 69 and SR 89
Flagstaff	Road, Rail	Peak hour bottleneck on I-17
Lake Havasu City	Road	Peak hour bottleneck on US-95
Bullhead City	Road	Peak hour bottleneck on US-95 and rural arterial 68
Sierra Vista	Road**	Peak hour bottleneck on rural arterial 90 near I-10
Nogales	Road, Rail	Mid-day bottleneck on I-19

Source: CPCS Analysis of CB Richard Ellis (CBRE) Dataset, HDR/CPCS Analysis of ATR Truck Bottleneck Data
*Prescott rail service was abandoned in 1990s
**Sierra rail service was abandoned in 1979

While this working paper introduces freight activity clusters across the state, the forthcoming sector working papers of Phase 3 will provide additional detail on the location, character, and connectivity of sector-specific clusters, including high-tech manufacturing, general manufacturing, mining, agriculture, food and beverage, wholesale trade, and other sectors.

8 Top Freight Mobility Constraints

Key Messages

While much of Arizona's multimodal transportation system currently supports efficient goods movement, top freight mobility constraints include, among other issues:

- Highway congestion in Arizona's urbanized areas and Key Commerce Corridors creates significant freight bottlenecks.
- Arizona's freight rail network is lacking in north-south infrastructure, including limits to rail capacity, intermodal facilities, classification yards, and logistics centers.
- Local congestion affects highway movements of air cargo utilizing PHX.

Funding the necessary improvements to operate and maintain the state's transportation network is by far the greatest challenge faced by Arizona. $18.8 billion of funding is needed over the next 20 years to adequately operate and maintain the current transportation network in the state's Key Commerce Corridors.

8.1 Arizona's Top Freight Mobility Constraints

This section presents a summary of the top mobility constraints affecting Arizona's freight transportation system, including truck, rail, air cargo, pipeline, and international trade crossings. Summaries of the system's operational and institutional performance, gaps in connectivity, policy, funding, and other issues identified throughout this working paper are presented below. These key constraints will be the basis for ADOT to define, screen, and prioritize the potential freight system and policy actions and strategies, projects, and solutions that best position Arizona for economic growth and opportunity in the future.

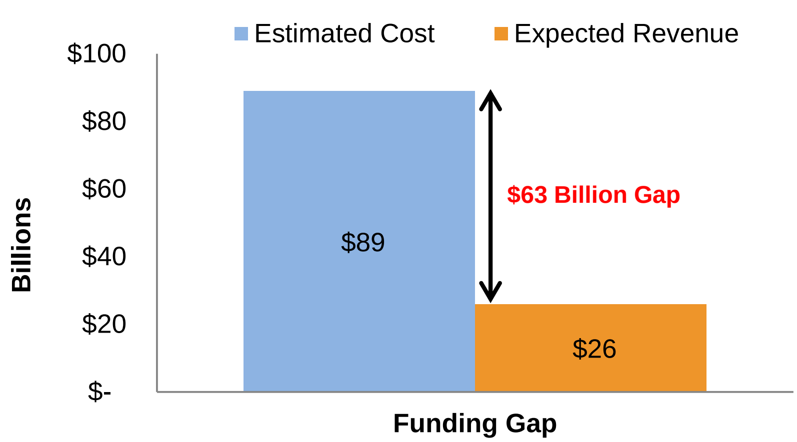
Mobility constraints are presented below for each system element, including highway, rail, air cargo, pipeline, and borders and international trade gateways.

8.1.1 Highway System Primary Mobility Constraints

Highway Freight System Funding

Funding the necessary improvements to operate and maintain the state's transportation network is by far the greatest challenge faced by Arizona. ADOT has reported that approximately $18.8 billion of funding is needed over the next 20 years to adequately operate and maintain the current transportation network in the state's Key Commerce Corridors. However, the operations and maintenance funding estimates do not include funding for new capital projects in these corridors. Arizona's Long Range Transportation Plan (What Moves You Arizona) has estimated that over the next 25 years, $89 billion will be needed to bring the state transportation system, including the freight systems in Key Commerce Corridors, to acceptable performance standards. This need considers the projected availability of $26 billion of expected revenues available to the state over this same period, a gap of $63 billion.

Figure 54: 25-Year Projected Funding Gap for State Transportation System



Source: Arizona's Long Range Transportation Plan (What Moves You Arizona)

Degrading system performance
Congestion in Arizona's urbanized areas and Key Commerce Corridors creates significant freight bottlenecks which are projected to further degrade over the next 25 years.

Bottleneck causes include primarily congestion, but local system trucking conflicts, facility design, terrain and geography, and border crossing wait times (in selected corridors) all contribute to system performance degradation.

The Arizona transportation (highway and rail in particular) network's lack of alternate routes (or redundancy) through urban areas currently causes delays and congestion with both local and through-freight movements and operations. Anticipated population growth, limited network redundancy and system improvements, among many other factors, will result in this congestion worsening over time. Figure 55summarizes bottleneck locations on Key Commerce Corridors.

Figure 55: Major Truck Bottleneck Locations along Arizona's Key Commerce Corridors

Map key	Commerce Corridor	Location	Direction	Major Contributing Factor				
				Congestion	Steep grades	Curves	Border crossings	Truck/local activity
T	I-17	MP 232 to 242 (near Black Canyon City)	Northbound		pm			
U	I-17	MP 298 to 306 (AZ 179 to Stoneman Lake Rd)	South		pm			
V	I-17	MP 329 to 331 (9 miles south of Flagstaff)	Northbound		mid			
W	I-10	At I-19 traffic interchange in Tucson	Both	am pm				
X	I-10	MP 36 to 40 (Wilcox area)	Both					am
Y	I-19	Nogales Port of Entry	Both				mid	
Z	SR 95	Within Lake Havasu City	Both	am pm				
AA	US 95	San Luis Port of Entry	Both				am pm	
BB	US 95	North of I-10	Both					am
CC	US 95	Parker Dam area	Both			pm		

DD	US 60	Within Gold Canon area (milepost 200 to 208)	Both					am mid
EE	US 60	At SR 79 junction	Both					am pm
FF	US 70	East of Globe (MP 252 to 259)	Both					am
GG	SR 87	within Payson at SR 260 (MP 249 to 258)	Both	am pm				
HH	US 93	South of I-40	Both	am				
II	SR 260	MP 274 to 282 (Christopher Creek area)	Both			mid		
JJ	SR 260	MP 303 to 313 (Heber area)	Both			am		
KK	I-40	East of Winslow area (MP 269 to 274)	Both					pm
LLS	US 60	At SR 177 (MP 224 to 228)	Both					am mid

Source: CPCS/HDR (2015)

8.1.2 Freight Rail System Primary Mobility Constraints

Lack of north-south rail infrastructure. Arizona's freight rail network is lacking in north-south infrastructure, including limits to rail capacity, intermodal facilities, classification yards, and logistics centers. Branch services of both the BNSF Railway and UPRR currently serve as the primary freight rail routes into and out of Phoenix from I-40 (BNSF) to the north and I-10/I-8 to the south (UPRR). This limited capacity impacts economic growth opportunities in the Phoenix metropolitan area. Freight rail service in the CANAMEX Corridor, a key economic corridor in Arizona, is also limited.

Source: The Arizona Republic

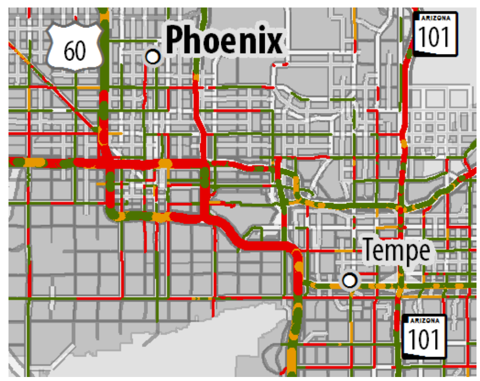
At-grade rail crossing impacts. At-grade rail crossings, seen in the figure at right, often cause roadway system congestion and delay to local roadway users, but also degrade the freight rail system's performance. These crossings can contribute to reduced transportation system safety, increased environmental and emission impacts, and quality of life issues for many communities across the state.

Through freight rail movement and economic growth opportunities. Arizona's current and potential future freight rail network is focused on through movements (about 75 percent). This situation provides limited opportunity for ADOT to facilitate the implementation of a better balance of rail and highway networks to meet the potential goods movement demands and expected economic growth opportunities of many communities in the state, including Phoenix, Tucson, and other urban regions in the state. Additional evaluation is needed to identify potential economic and sector growth strategies that will ultimately provide a better balance to Arizona's freight rail system. These efforts are currently also limited by the lack of rail-served industrial sites, especially in the Phoenix region.

Continued focus on communication between private railroads, ADOT, and stakeholder partners. The BNSF Railway and UPRR have and will continue to invest heavily in improving both their transcontinental services through Arizona (BNSF's Transcon, UPRR's Sunset Corridors) and branch services (Phoenix Subdivisions) into and out of Phoenix. In order for these investments to meet the future transportation system goals and needs of both the railroads and ADOT/agency partners, a continued focus on increasing the levels of communication, understanding of political and policy needs, and definitions of implementation strategies must be addressed collaboratively to achieve the long-term freight rail system goals for both ADOT and the railroads.

8.1.3 Air Cargo System Primary Mobility Constraints

Concentration of activity into/out of Sky Harbor International Airport. Approximately 90 percent of statewide air freight is shipped through Phoenix Sky Harbor International Airport, located in the center of the Phoenix metropolitan area. This level of air cargo activity and resulting truck movements have significantly increased roadway congestion and delay in the surrounding area. This is exacerbated by air cargo arriving in Phoenix limited to truck movements/activity on one route, 24th Street. Over the past ten years, ADOT, MAG, and other regional agencies have evaluated alternative truck routing into and out of Sky Harbor Airport and studied the potential location of expanded air cargo services of other regional airports (e.g. Phoenix-Mesa Gateway) to identify ways of alleviating these localized impacts.



Source: CPCS/HDR Analysis of ATRI Data 2015

8.1.4 Pipeline System Primary Mobility Constraints

Storage capacity and constraints. A lack of storage capacity in Arizona's pipeline system provides little inventory and/or options (e.g. redundancy) to redistribute materials in the event of system disruptions. In addition, capacity constraints with petroleum pipelines may result in additional shipments by rail and/or truck, which burdens the highway and rail systems and introduces safety concerns, especially with the potential shift of the movement of highly flammable materials to either truck or freight rail.

Funding/infrastructure approvals. As with freight rail projects, the capital costs associated with pipeline development and regulatory approval contribute to time and cost implications to deliver new pipeline projects. Increased communication between these private companies, ADOT, and its partners will be needed to better understand the truck, rail, and pipeline trade-offs and needs into the future.

8.1.5 Borders and International Trade Gateways Primary Mobility Constraints

Limited LPOE capacity and poor roadway connections. Like most Ports of Entry on the U.S.-Mexico border, most Arizona Land Ports of Entry (LPOEs) experience capacity constraints. In many cases, as with Arizona LPOEs, this is a result of inefficient operations in facility design, security concepts and institutional issues, long-standing international agreements and laws, and intermodal conflicts (e.g., parking areas, waiting areas, security between trucks, personal autos, and pedestrians). In addition, these operational flaws are exacerbated by the general poor condition and limited capacity of road network leading to and from the LPOEs. This situation also includes limited design issues with the LPOEs with increased intermodal conflicts with parking/waiting area constraints.

Nogales Mariposa LPOE
Source: Google Maps (2014)

8.2 Implications

The above constraints, system bottlenecks as well as institutional issues, will be the basis for ADOT to define, screen, and prioritize the potential freight system and policy actions and strategies, projects, and solutions that best position Arizona for economic growth and opportunity in the future. For example, institutional actions and strategies will need to be defined to create a better balanced freight rail system in Arizona, not just focused on moving goods through Arizona, but on defining ways to expand and increase north-to-south freight services to make the state's metropolitan areas and rural areas more accessible for the industries that move goods. In Phase 5, actions and strategies, projects, and solutions will be designed to meet the above needs in concert with the development of a freight transportation network in Arizona that links with economic growth opportunities related to Arizona's key industrial sectors anticipated for Arizona's future.

Appendix A: List of Stakeholders Consulted

Name	Title	Organization
Sergio Martínez González	Subsecretario	Subsecretaría de Desarrollo Económico (Secretaría de Economía)
Julie Engel	President	Arizona Association for Economic Development
Nils Urman	Chairman	Economic Development & Tourism Advisory Board, Nogales (Arizona)
Aaron White	Economic Development Specialist	City of Nogales, Arizona
Carolina Martínez de Castillo	Directora	Desarrollo Económico de Nogales, Sonora
Miguel Angel Figueroa Gallegos	Presidente (interino)	Cámara Nacional de Comercio (CANACO) Hermosillo, Sonora
Lance Jungmeyer	President	Fresh Produce Association of the Americas
Randy Payne	Airport Planner	City of Phoenix, Aviation Department
Dick Gruentel	Airport Planner	Tucson Airport Authority
Barb Hempel	Airport Planner	Tucson Airport Authority
Gil Martinez	Financial Reporting	Ameriflight
Shane France	Manager	FedEx
Todd Watkins	Director of Maintenance	Sierra Pacific
Tim Reddoch	Station Manager	Matheson Flight
Shirley Cornett	Superintendent	Apache Railroad
Tanya L. Cecil	General Manager	Arizona and California Railroad
Robin Brean	General Manager	Arizona Central Railroad
Preston Nelson	General Manager	Arizona Eastern Railway
Joseph Wilhelm	General manager	ASARCO Hayden plant railroad
Kent Fletcher	General Manager	BHP Arizona Railroad (former Magma Arizona Railroad, now part of Capstone)
Garland Horton	VP Sales and Marketing	Copper Basin Railway
Mike Pieterick	Manager	Grand Canyon Railway
Job Luque	General Manager	JBS Five Rivers Cattle Feeding-McElhaney Feeders

Stefan Baumann	Director of Business Development	Port of Tucson
Jamie Brown	Senior Transportation Planner	Pima Association of Governments (PAG)

Appendix B: Supplemental Figures and Maps

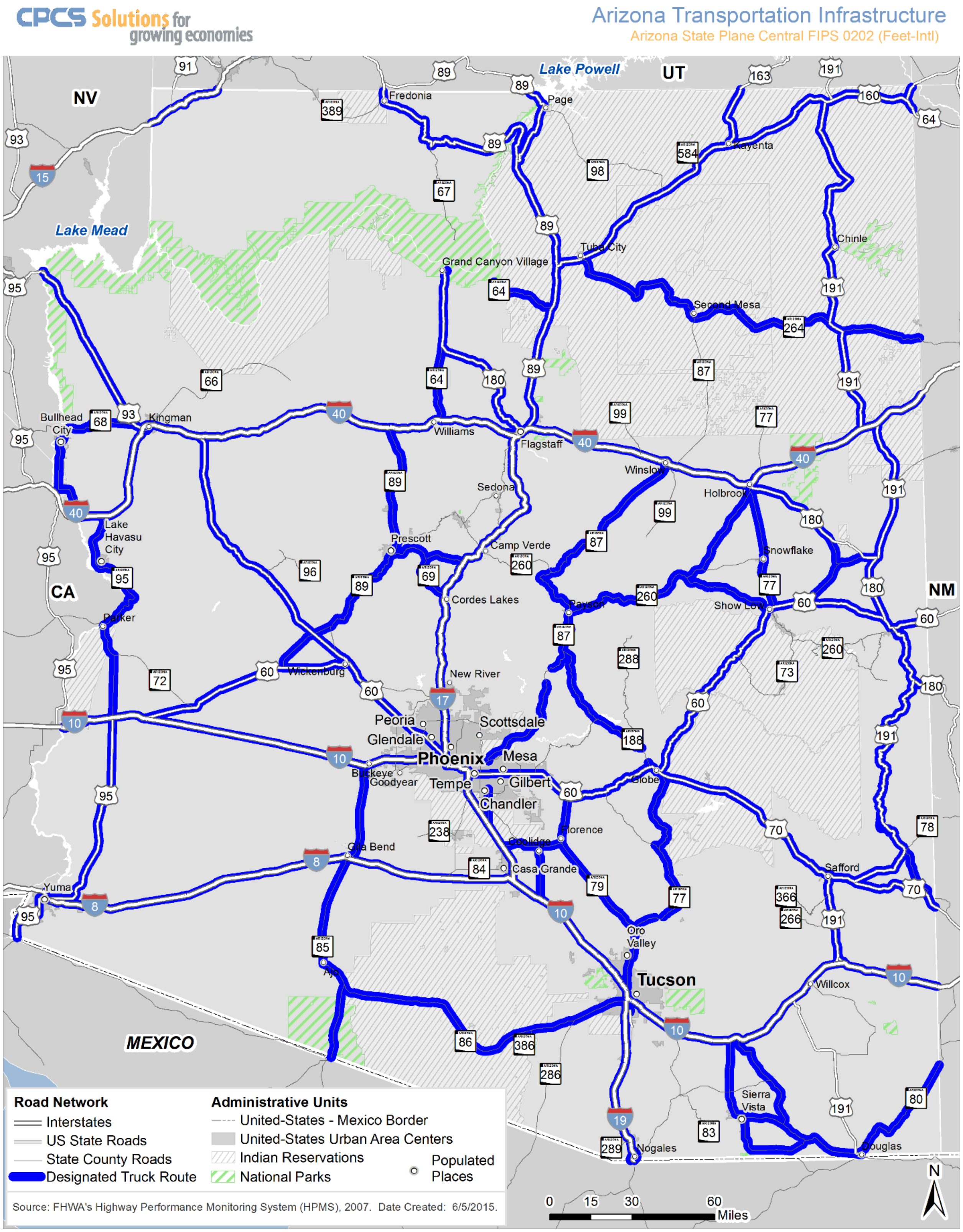
The following supplemental figures and maps provide additional details on the inventory of freight transportation system assets in Arizona.

Designated Truck Routes

Designated truck routes are routes designated for use by dimensioned commercial vehicles under the Surface Transportation Assistance Act of 1982, as identified in 23 Code of Federal Regulations (CFR) 658, Appendix A. Nationally designated truck routes include the Interstate system; non-Interstate routes specifically listed in 23 CFR 658, Appendix A, as amended; and the other non-Interstate existing Federal-aid Primary routes as defined in 1991 that Surface Transportation Assistance Act-dimensioned commercial vehicles may legally operate on.

Figure 56 shows designated truck routes throughout Arizona. This information was derived from the 2007 Highway Performance Monitoring System (HPMS) roadway network. The dataset uses an administrative identifier to determine whether a roadway section is on or off a truck route designated under federal regulatory authority.

Figure 56: Designated Truck Routes



Draft Primary Freight Network

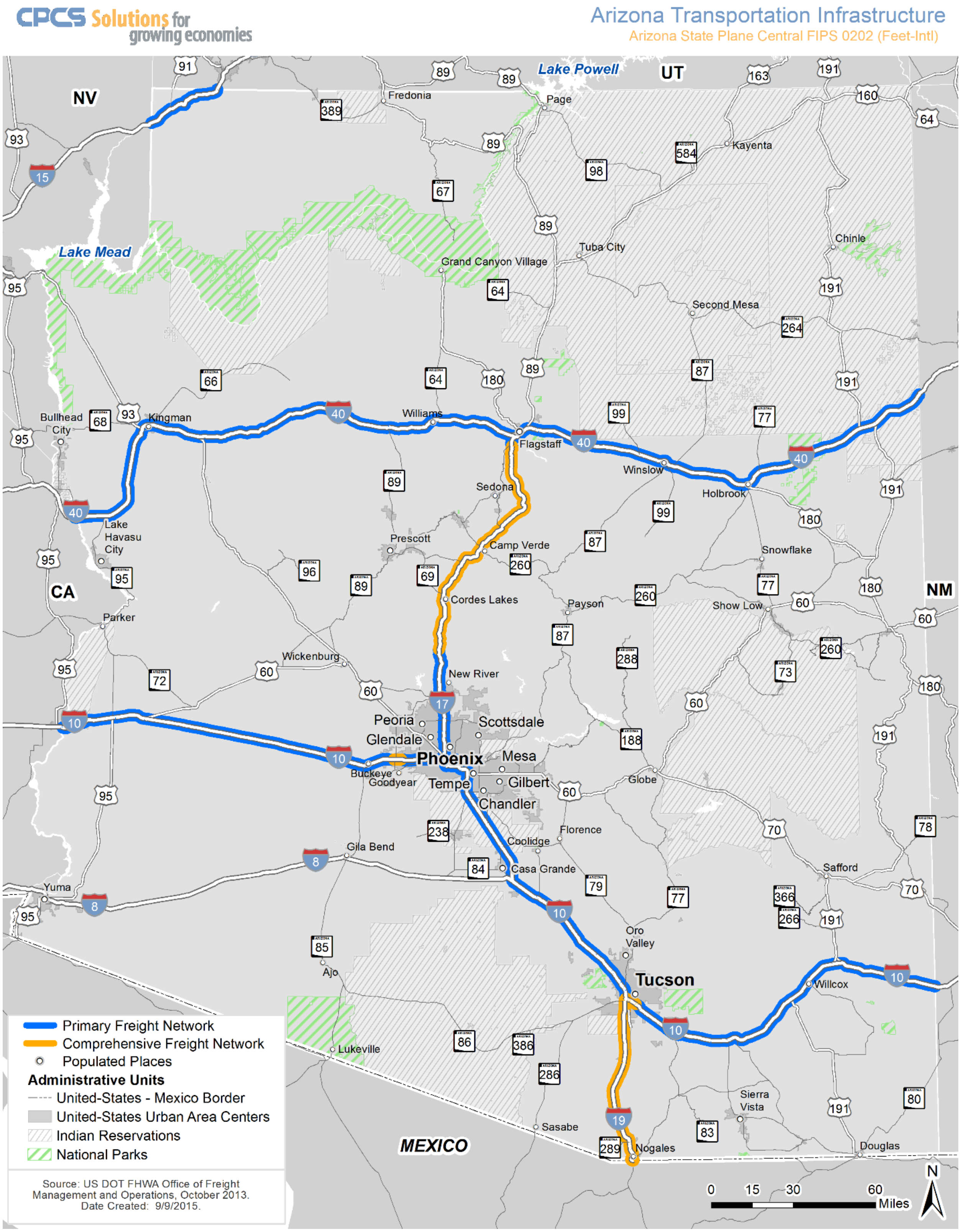
MAP-21 established a policy and programmatic framework for investments to guide the national transportation system's growth and development. MAP-21 directed FHWA to establish a national freight network to assist states in strategically directing resources toward improved system performance for efficient movement of freight on the highway portion of the nation's freight transportation system

FHWA initially identified 41,518 interconnected centerline miles, including 37,436 centerline miles of Interstate and 4,082 centerline miles of non-interstate roads as important to freight movement based on eight methodology criteria. However, since MAP-21 limited the primary freight network to 27,000 centerline miles, those segments with the highest average annual daily truck traffic flows were designated as the draft highway Primary Freight Network (PFN). Congress instructed U.S. Department of Transportation (USDOT) to base the highway PFN on an inventory of national freight volume conducted by the FHWA Administrator, in consultation with stakeholders, including system users, transport providers, and states. Congress defined eight factors to consider in designating the highway PFN:

1. Origins and destinations of freight movement in the United States;
2. Total freight tonnage and value of freight moved by highways;
3. Percentage of annual average daily truck traffic in the annual average daily traffic on principal arterials;
4. Annual average daily truck traffic on principal arterials;
5. Land and maritime ports of entry;
6. Access to energy exploration, development, installation, or production areas;
7. Population centers; and
8. Network connectivity.

The entire stretch of I-10 (New Mexico to California), I-19 (Nogales to Tucson), I-17 (Phoenix to Flagstaff), I-40 (New Mexico to California), and I-15 (Nevada to Utah) are designated as the draft PFN routes in Arizona (Figure 57).

Figure 57: Draft Primary Freight Network



Critical Rural Freight Corridors

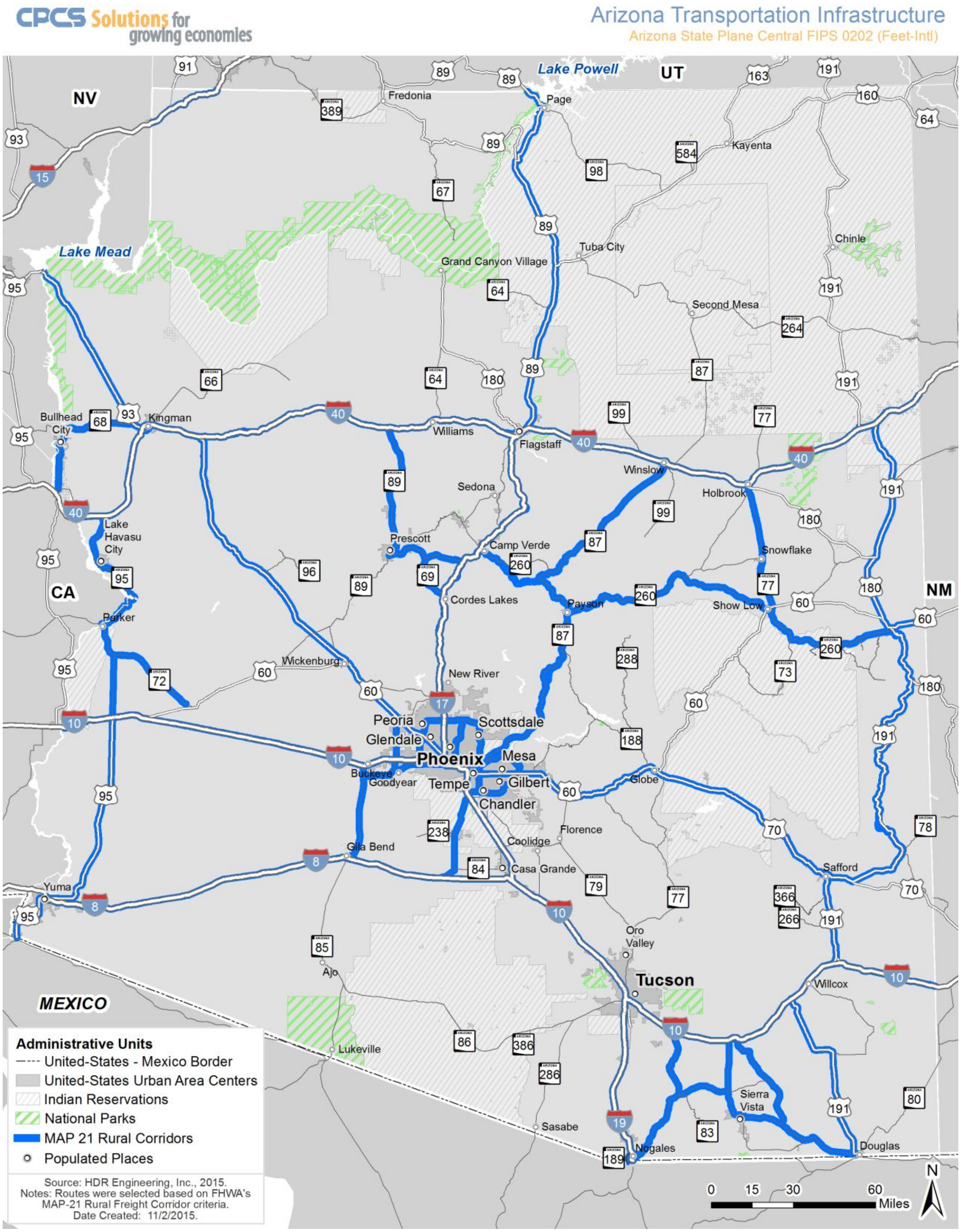
National Freight Policy (Section 1115) encourages each state to identify critical freight corridors to enhance freight mobility and to establish better connectivity and accessibility to the national freight network system. For a road to be designated a critical rural freight corridor, it must meet one of the three criteria shown in Figure 58.

Figure 58: Rural Freight Corridor Criteria

Criterion	Selection Approach
The road is a rural principal arterial road and has a minimum of 25 percent of the annual average daily traffic of the road measured in passenger-vehicle equivalent units from trucks (FHWA vehicle classes 8 to 13)	HPMS roadway functional classification was reviewed to identify the Rural Principal Arterials. ADOT traffic counts comprising the trucks were used to identify multiunit trucks. The segments meeting these criteria were identified
The road provides access to energy exploration, development, installation, or production areas.	Major mining facilities throughout the state were located, and roadways providing access to these mining facilities were identified.
The road connects the primary freight network, a road described in paragraphs one or two, or Interstate system to facilities that handle more than: a. 50,000 20- foot equivalent units per year; or b. 500,000 tons per year of bulk commodities.	The Freight Analysis Framework Version 3 (FAF3) estimates commodity movements by truck. The FAF3 commodity flow model assigns daily freight trucks along major freight corridors, and the annual truck kilo-tonnage (2007) is reported to the roadway network links. The FAF3 network database, flow assignment, and annual kilo-tonnage (2007) were used to identify the roadways meeting this condition.

The roadway links meeting at least one of the above three FHWA criteria are shown in Figure 59.

Figure 59: MAP-21 Critical Rural Freight Corridors



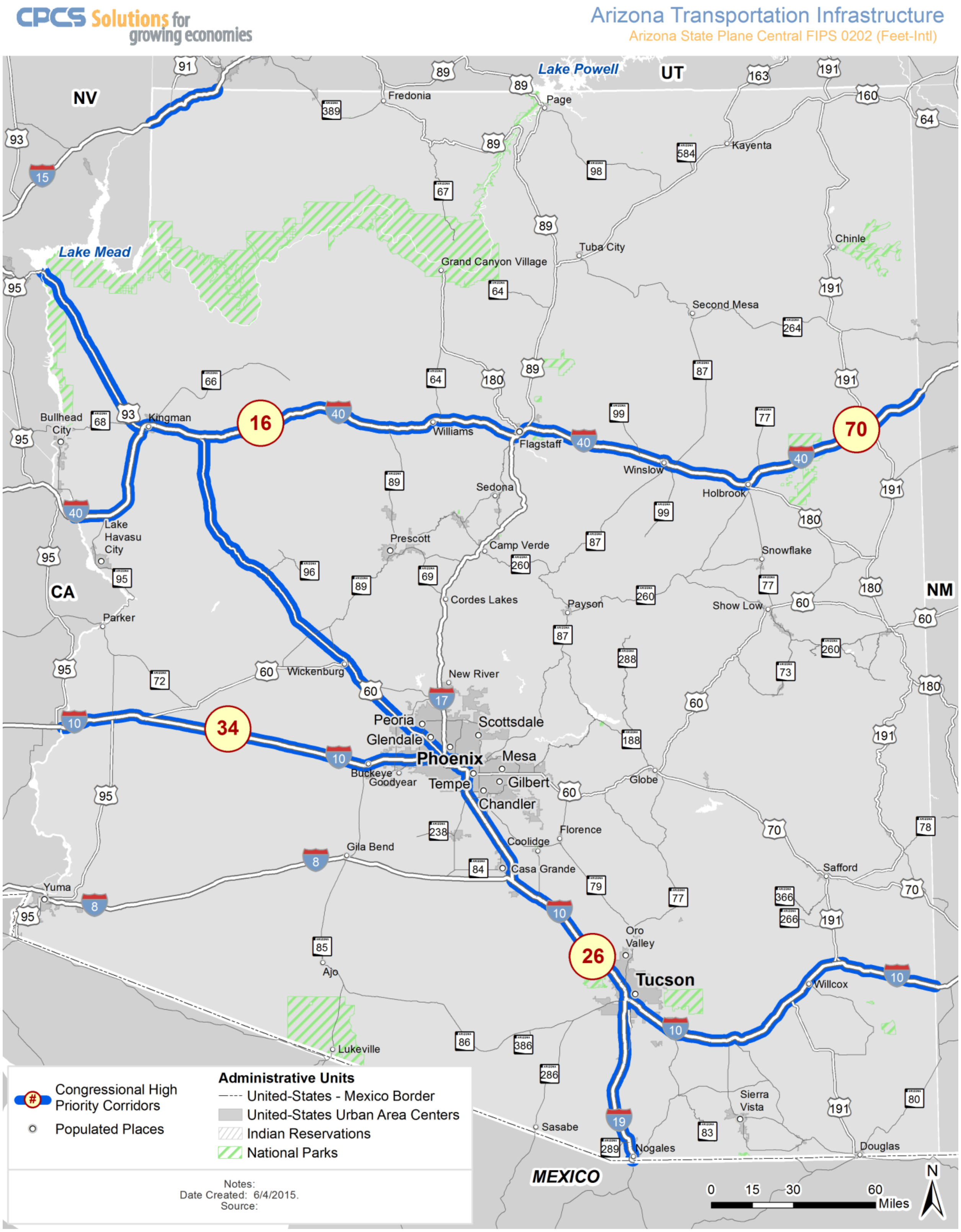
Congressional Freight Corridors

The Congressional High-Priority Corridors are established by USDOT under the provisions of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (Public Law 109-59). Within Arizona, four corridors are listed under this category (FHWA 2008):

- #16 and #70: Economic Lifeline Corridor along I-15 and I-40 in California, Arizona, and Nevada
- #26: CANAMEX Corridor, which will generally follow I-19 from Nogales to Tucson; I-10 from Tucson to Phoenix; U.S. Route 93 in the vicinity of Phoenix to the Nevada border (future Interstate 11); and the Economic Lifeline Corridor along I-15 and I-40
- #34: Alameda Corridor (I-10 between California and Phoenix and between Tucson and New Mexico within Arizona).

The corridor numbers correspond to the statutory listing in Section 1105(c) of the Intermodal Surface Transportation Efficiency Act.

Figure 60: Congressional Freight Corridors

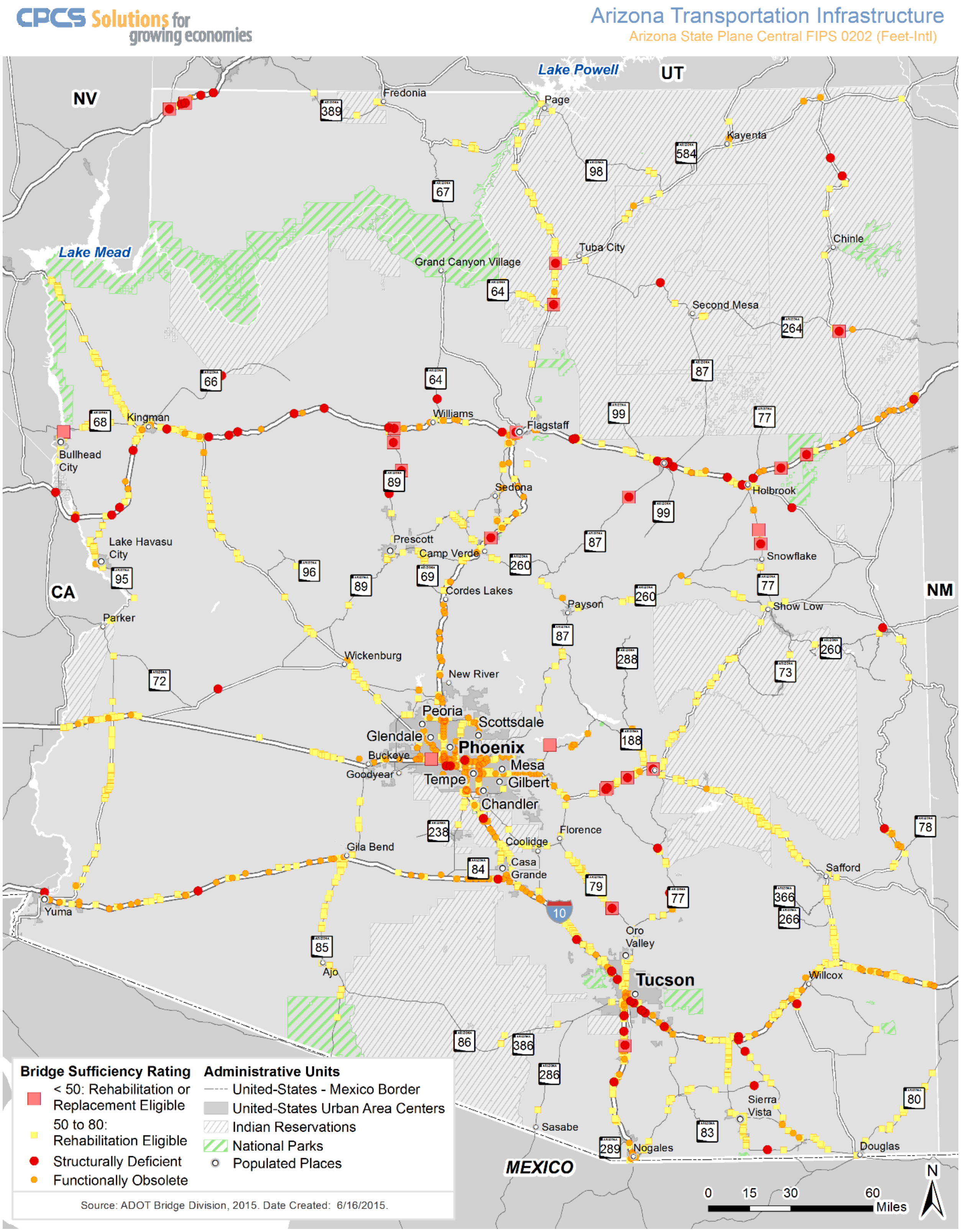


Bridge Conditions

Bridge conditions are presented by their sufficiency ratings and deficiency type. On a scale of 0 to 100, bridges with sufficiency rating greater than 80 are considered in good condition. Deficient bridges with sufficiency ratings of over 50 and less than 80 are eligible for rehabilitation only, but can be replaced if economically justifiable. Deficient bridges with a sufficiency rating of less than 50 are eligible for either rehabilitation or replacement. Based on the structural condition assessment, bridges are also classified as "functionally obsolete" or "structurally deficient." Whereas the sufficiency rating is based on an inspection of the bridge strength and conditions, a designation of being obsolete or deficient typically means that the structure does not meet current criteria pertaining to shoulder width, railing types, and vertical clearances.

Some of the major truck corridors such as I-40, I-17, I-19, and I-15 have a number of bridges that have either a sufficiency rating less than 80 and/or are designed as structurally deficient and/or functionally obsolete. Arizona's Key Commerce Corridors (ADOT 2014b) identified the number of bridges with immediate needs and estimated $400 million in rehabilitation and reconstruction costs. There are 40 additional bridges with immediate needs throughout the state. Figure 61 shows bridge conditions for the state highway system.

Figure 61: Bridge Conditions



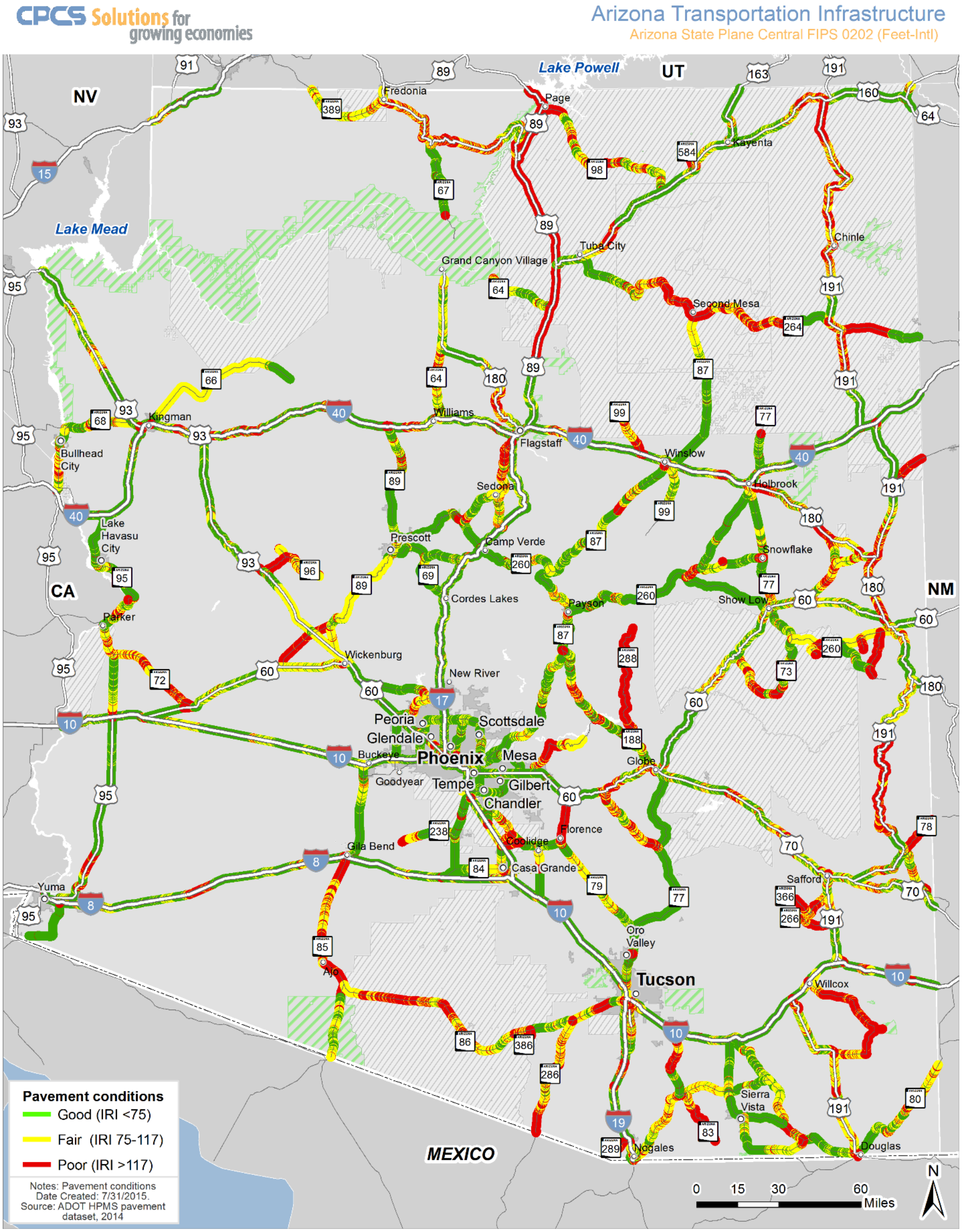
Pavement Conditions

ADOT's Materials Group maintains a dataset related to pavement conditions on state highway facilities. Pavement conditions are assessed based on a subjective measurement of pavement smoothness, known as the International Roughness Index (IRI), measured in inches per mile. The lower the IRI value, the smoother the pavement condition. Higher IRI value represents deteriorated pavement conditions and drivable only at reduced speeds. The IRI thresholds of less than 75, between 75 and 117 and greater than 117 were used to represent good, fair and poor pavement conditions, respectively.

Figure 62 shows the pavement condition for the state highway system. Analysis of 2014 statewide pavement condition shows that of approximately 8,700 miles of ADOT-owned directional roadways, about 4,600 miles (53 percent) are reported as being in good condition, 2,400 miles (28 percent) are in fair condition, and the remaining 1,700 miles (20 percent) are in poor condition.

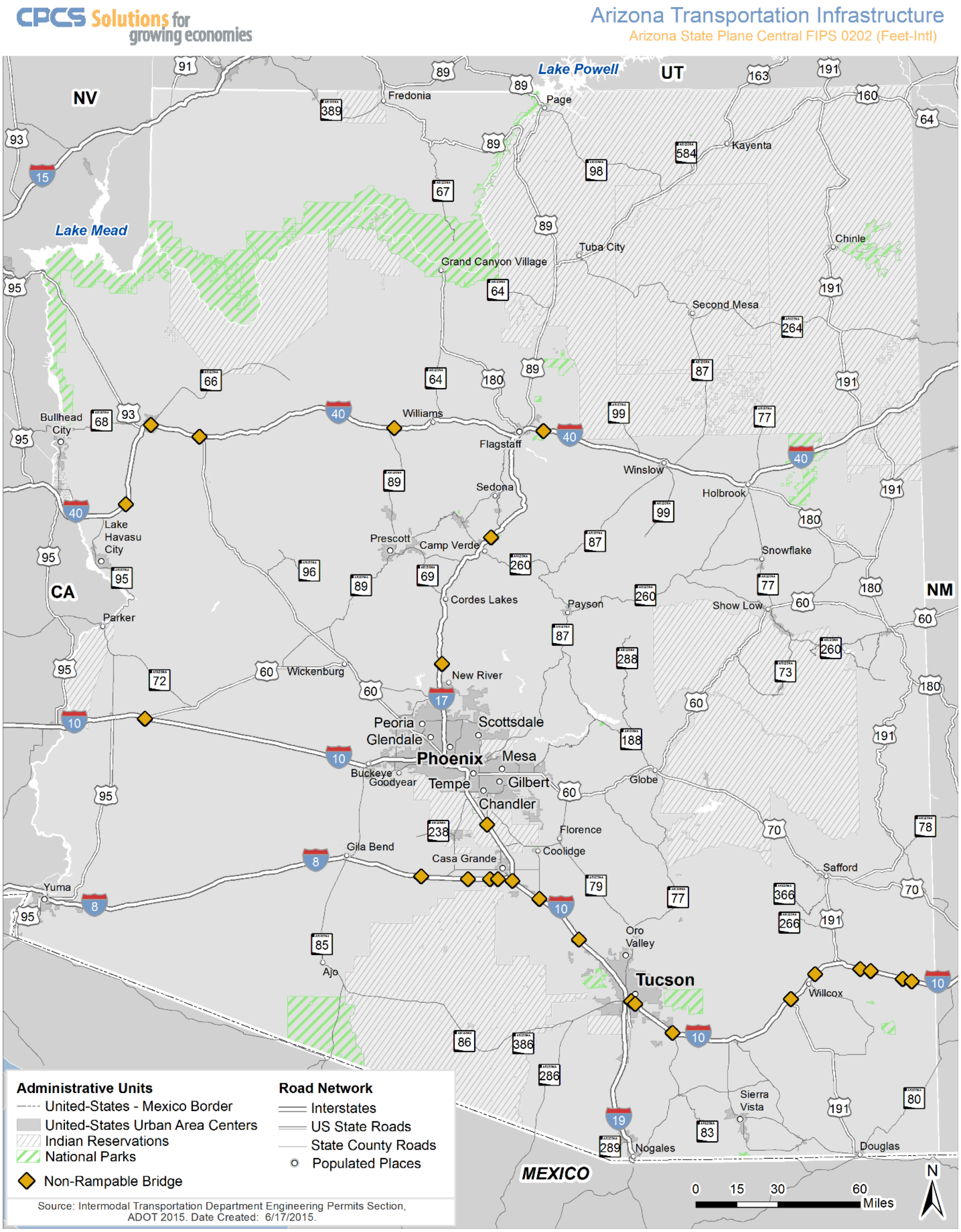
ADOT is currently conducting corridor profile studies along six major routes within Arizona. The condition assessment of three major Interstate facilities (I-19, I-17, and I-40, Flagstaff to Nevada border) are now complete. Overall the studies noted that I-40 has good pavement conditions with the exception of the Kingman area west to U.S. Route 93 and the Bellmont area (west of Flagstaff). The poor pavement condition along these sections of I-40 are partially attributable to freeze-thaw cycles and de-icing treatments applied in winter months. I-19 has some areas within the Tucson area as well as near the U.S.-Mexico border near Nogales where poor pavement conditions were reported. I-17 has segments within the Flagstaff area where poor pavement conditions were reported. Pavement condition along the northbound direction is worse than the southbound direction as a result of loaded truck activity; trucks typically drive loaded in a northbound direction through Flagstaff to the Midwest and are unloaded in the southbound direction returning to Phoenix.

Figure 62: Pavement Conditions



Truck Restriction at Low Clearance Bridges. ADOT's Intermodal Transportation Division Engineering Permits Section provided a dataset comprising locations at low vertical clearance bridges where exit ramps do not exist. Vertical clearance issues restrict truck travel, whereby trucks must use exit ramps to avoid the low clearance locations. Restrictions cannot be avoided where exit ramps do not exist. 16 feet is the minimum standard vertical clearance value for Interstate bridges. Figure 63 shows locations with vertical clearances below the minimum standard, identifying their location and whether the restricted area can be avoided.

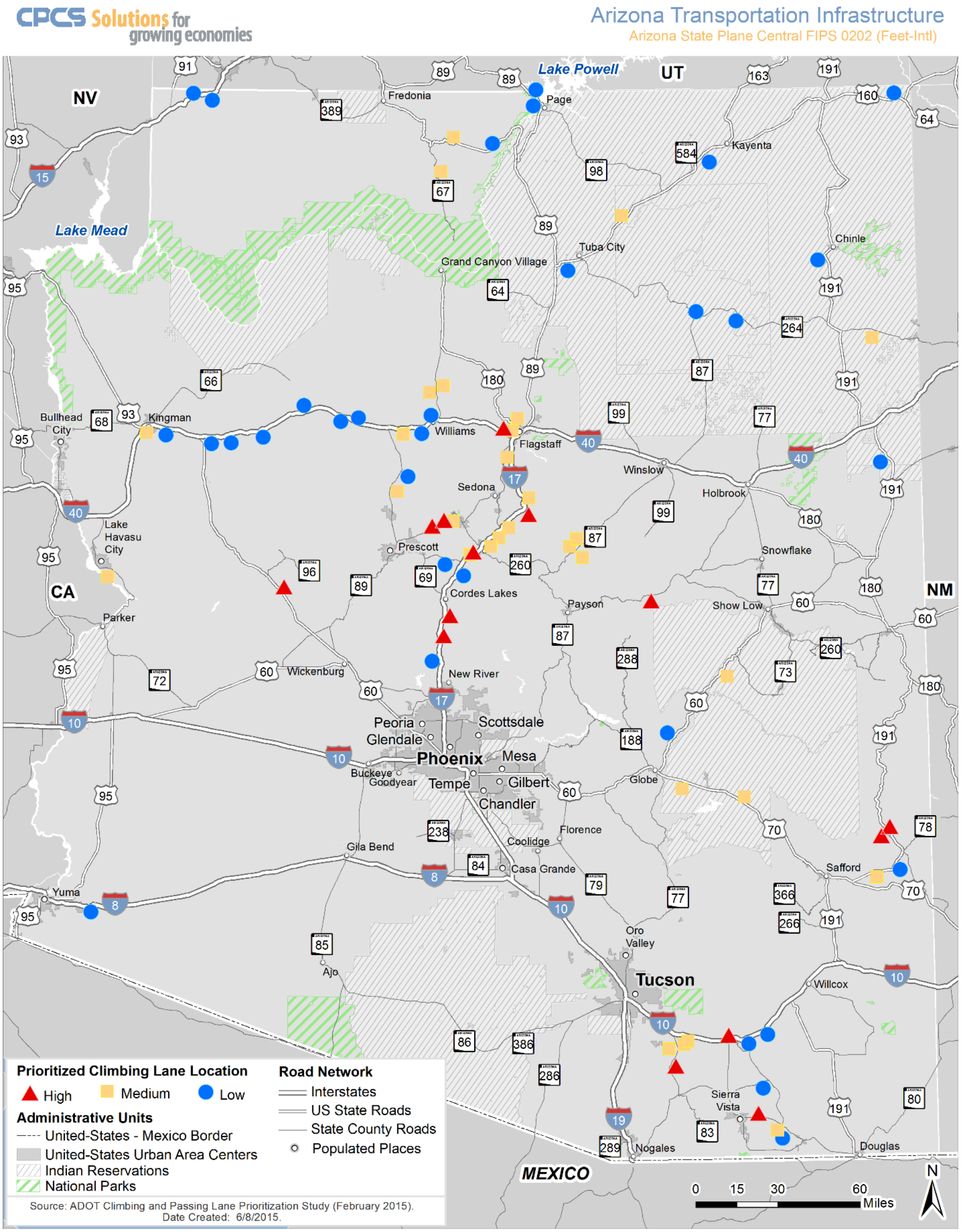
Figure 63: Truck Restrictions at Low Bridge Clearance Locations



Prioritized Climbing Lanes

For two-lane highways with moderate to high traffic volume levels, the lack of passing opportunities at regular intervals often results in long queues and poor system performance. For two-lane roadways in areas of topographic relief, trucks and other slow-moving vehicles experience a significant drop in speed, causing long queues and poor performance even with low traffic volumes. ADOT’s Climbing and Passing Lane Prioritization Study recommended six high-priority climbing lanes on multilane highways, primarily along I-17, I-10, and I-40 (ADOT 2015b). Additionally, the study recommended eight high-priority locations on two-lane highways to implement climbing lanes. Figure 64 shows the recommended locations where climbing lanes are prioritized along two-lane and multilane highways.

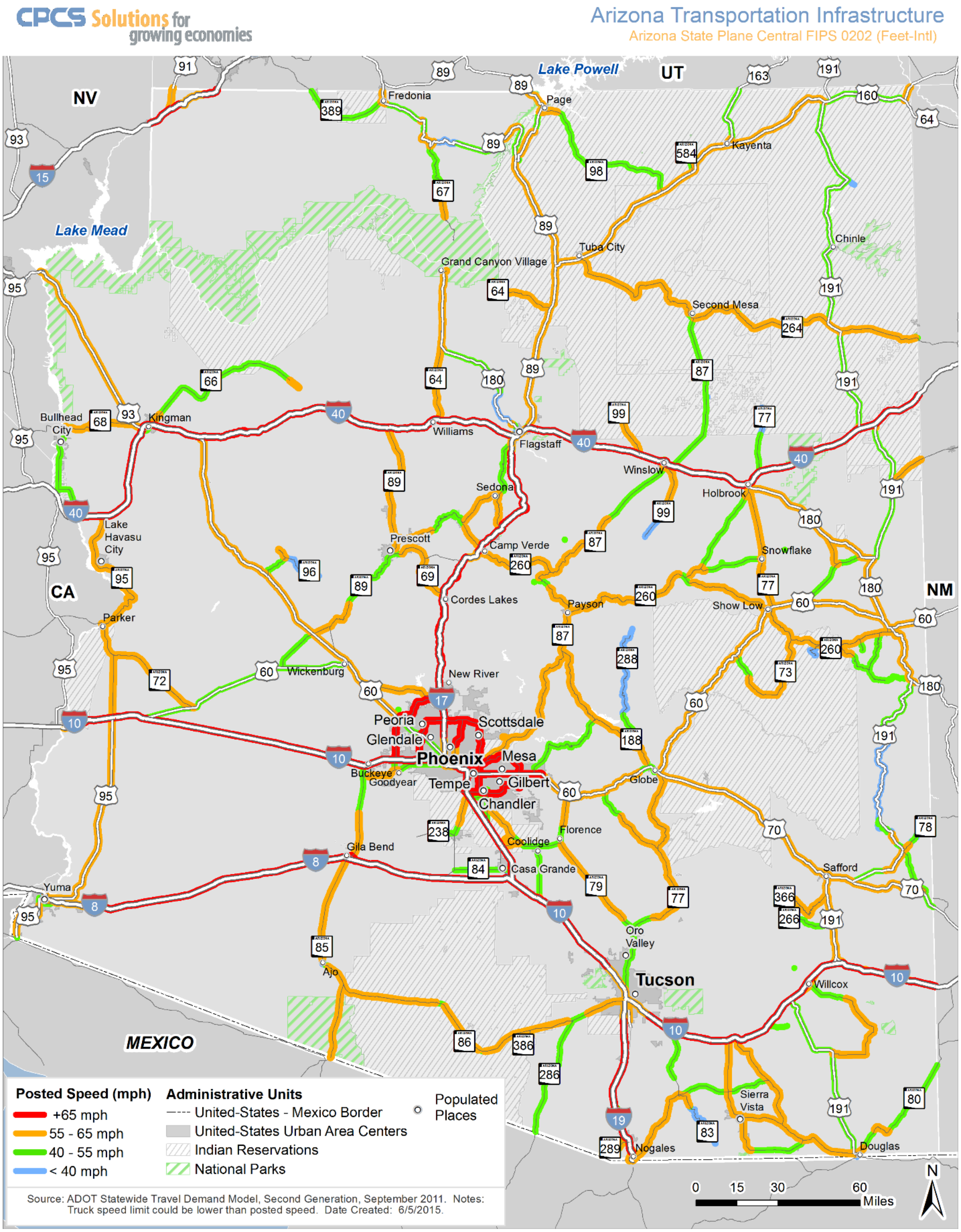
Figure 64: Prioritized Climbing Lanes



Posted Speed Limit

Figure 65 shows the posted speed limit. Outside the urban areas, Interstate facilities including I-10, I-17, I-15, I-8, and I-40 generally have a posted speed limit of 75 miles per hour (mph). In urban areas, the posted speed limits are lower. Posted speed limits along state and U.S. routes are typically 65 mph. It is important to note that truck operating speeds are typically lower as a result of steep grades, sight distances, and nighttime visibility. The ADOT Roadway Design Guidelines suggest a truck speed reduction of up to ten mph can be assumed to not significantly affect the capacity of a highway (ADOT 2012). Consideration should be given to providing additional lanes for any highway where the truck speed reduction because of the length of grade is greater than ten mph and there is a significant reduction in level of service when moving from the approach segment to the grade.

Figure 65: Posted Speed Limit



AM, Mid-day and PM peak Bottleneck Maps

Morning, mid-day and afternoon peak period bottleneck locations were identified using the American Transportation Research Institute (ATRI) dataset. ATRI provided real time truck operating speed data within the State for the following time periods in 2014:

- First two weeks February
- First two weeks May
- Last two weeks July
- First two weeks October

The time periods were selected such that the data represents the entire year considering the Arizona summer and peak winter visitor months. Using the ATRI data, Truck Travel Time Index (TTTI) was calculated dividing free-flow travel time by average peak period travel. The study used nighttime speed as free-flow travel time, since the posted truck speed limit along the State facilities were not available. TTTI represents the additional time spent in traffic during peak period when traffic volumes are typically heavy. The following thresholds were used to identify the bottleneck locations.

- Good < 1.15
- Fair 1.15 to 1.33
- Poor > 1.33

It is assumed that the higher the TTTI value, the more severe the bottleneck, meaning a longer time spent in traffic during the peak period. ADOT's current corridor profile studies used similar method to compute TTTI.

Figure 66 through Figure 68 shows the bottleneck locations by various peak period of the day. As shown in the map, congestion is severe within the Phoenix Metropolitan Area and Tucson, resulting many bottleneck locations. Steep grades (I-17 northbound), corridors with high percent truck traffic (I-10, I-40), urban congestion, and US-Mexico port-of-entry locations (Nogales, San Luis) contribute to bottleneck locations throughout the State.

Figure 66: Arizona Freight Corridor Bottleneck: Morning Peak

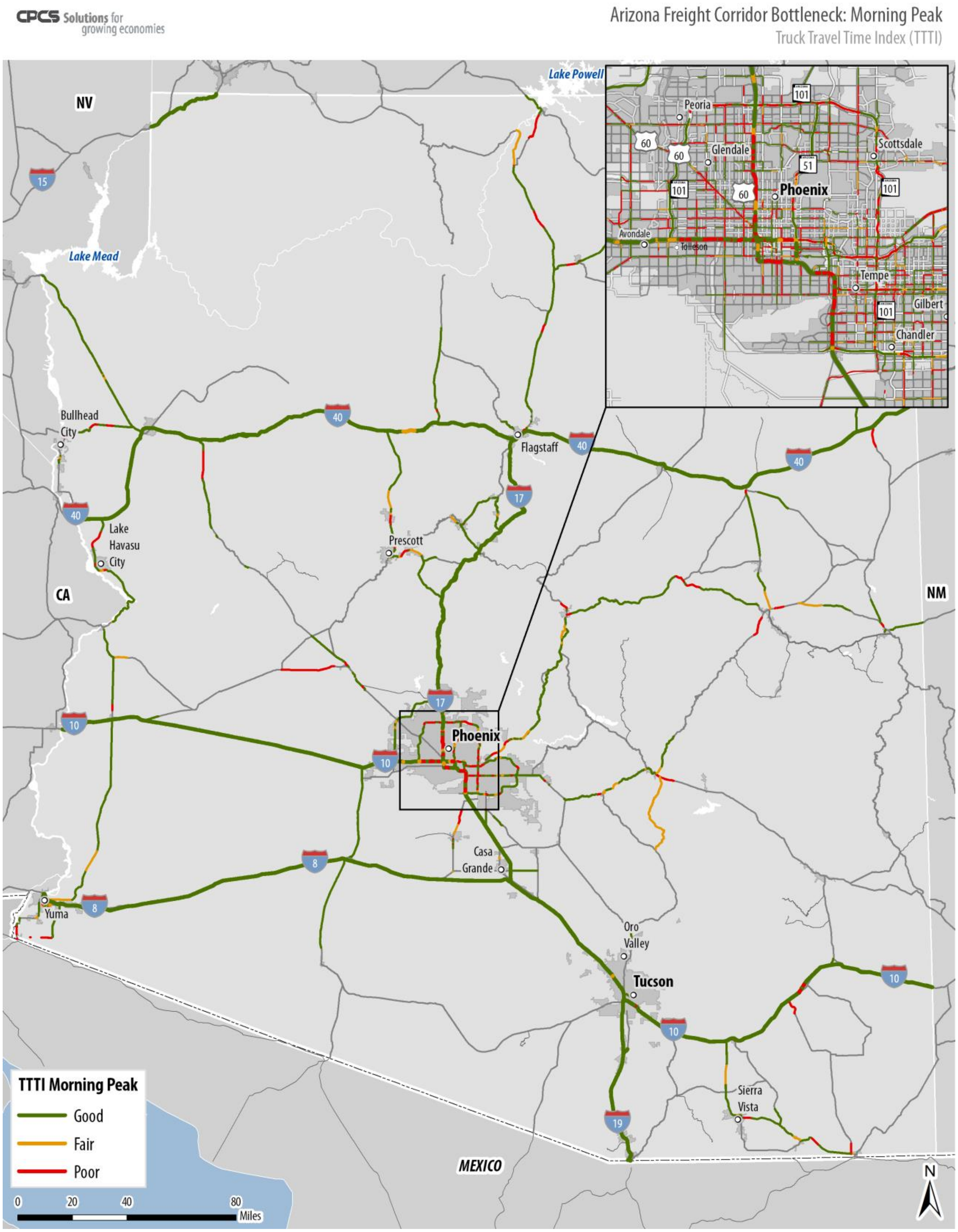


Figure 67: Arizona Freight Corridor Bottleneck: MidDay Peak

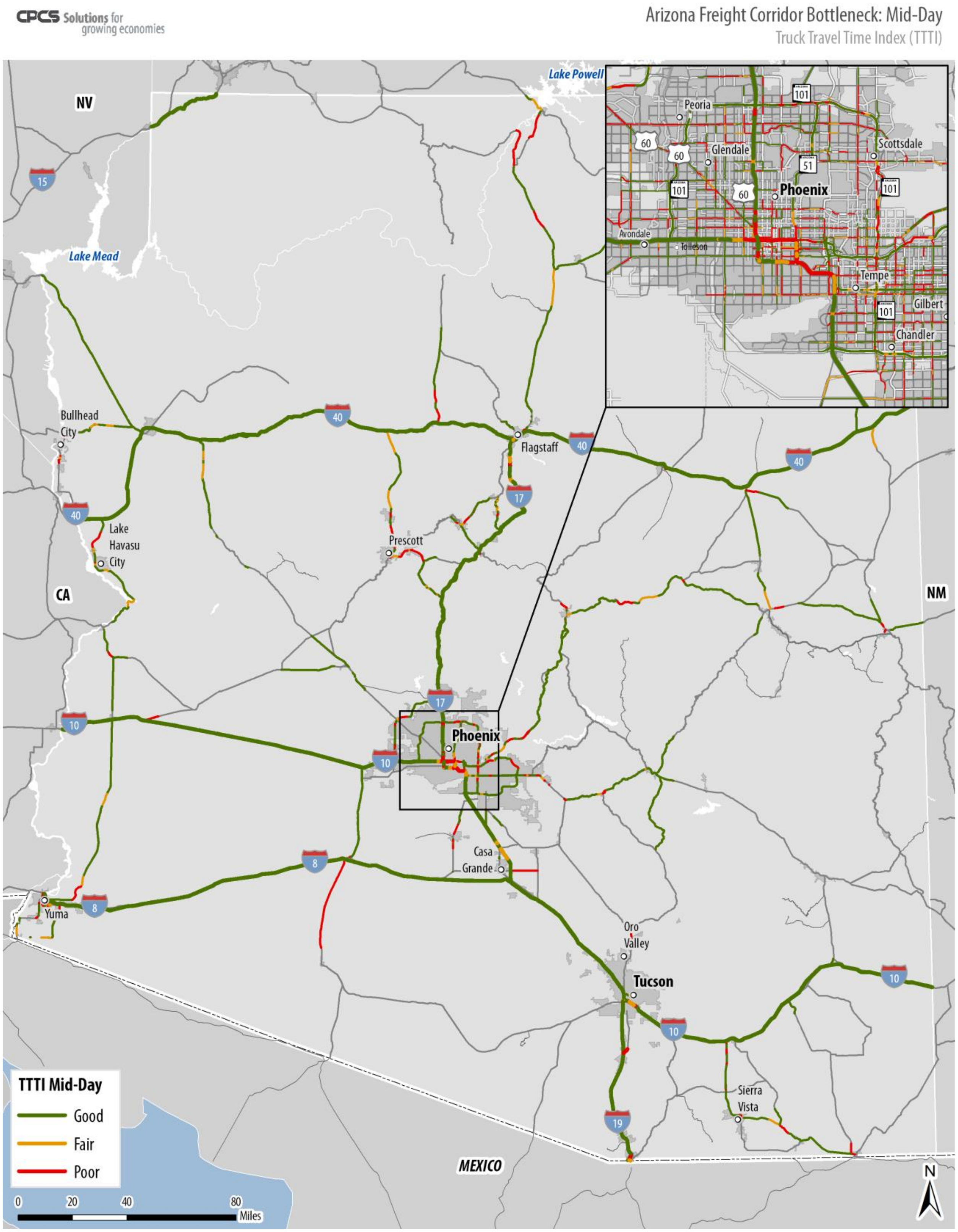
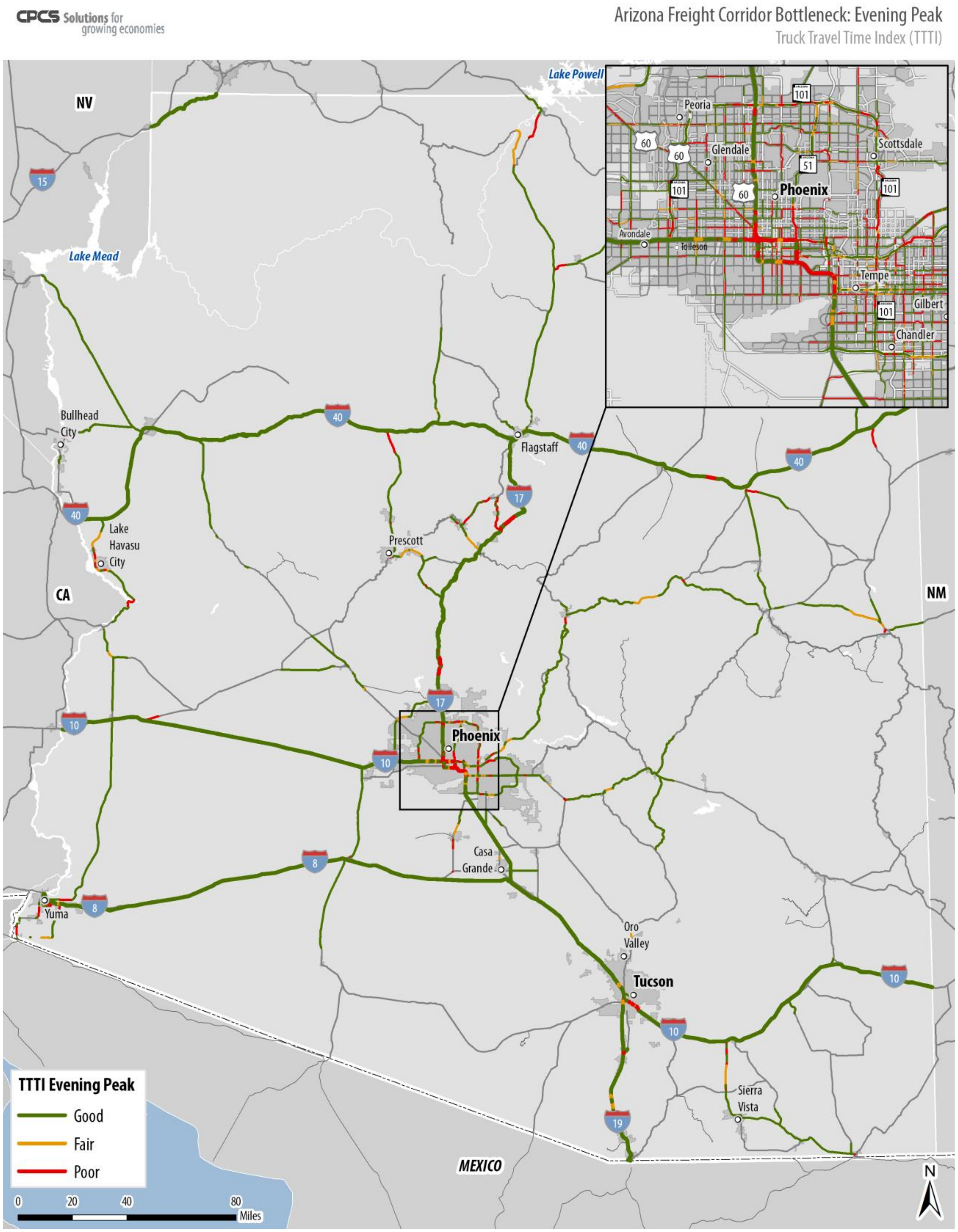


Figure 68: Arizona Freight Corridor Bottleneck: Evening Peak



Freight Railroad Infrastructure Detail

Building on the descriptions of Arizona freight railroad infrastructure provided in Section 3, the following information contains additional depth.

BNSF Railway Facilities

BNSF's Transcon Corridor, the company's main line service, is a key freight corridor crossing northern Arizona in the I-40 corridor, overlapping with two ongoing Corridor Profiles including I-40 from Flagstaff to the California border and I-40 from the New Mexico border to Flagstaff.

BNSF's Phoenix Subdivision overlaps with both the Key Commerce Corridor and Corridor Profile into and out of Phoenix even though the rail right-of-way is farther west of I-17 from Flagstaff to Phoenix. This branch line also overlaps with portions of the I-11 (or U.S. Route 93) Key Commerce Corridor and U.S. Route 93 Corridor Profile (designated for future analysis) parallel to U.S. Route 93/U.S. Route 60 between Wickenburg and Phoenix.

BNSF's Coronado Subdivision covers 45.4 route miles linking the Salt River Project Coronado Power Plant with the BNSF Transcon Corridor near the New Mexico/Arizona border. Extending from the Coronado Subdivision at the Salt River Power Plant is the Springerville Subdivision, extending an additional 29.7 route miles to the Tucson Electric Power Company Springerville Generating Station at Tepco Junction.

Union Pacific Railroad Facilities

UPRR's Sunset Route, the company's main line service, is also a key freight corridor crossing southern Arizona in the I-10 and I-8 corridors. The Sunset Route runs south of Phoenix from Yuma to the New Mexico border and overlaps with several Key Commerce Corridors including I-10 from the New Mexico border to Tucson, portions of I-10 to Phoenix (Tucson to Casa Grande), and I-8 from Casa Grande to Yuma. This service also overlaps with several Corridor Profiles (designated for future analysis) including I-10 from New Mexico to Tucson and portions of the I-10 Tucson to Phoenix Corridor Profile (from Tucson to Casa Grande).

UPRR's Phoenix Subdivision is the primary freight service in both the I-10 and I-8 Phoenix to Yuma/California border Key Commerce Corridors and Corridor Profiles (of which I-8 is underway), even though the majority of this service's right-of-way is located between I 10 and I-8 west of Phoenix. This service's eastern leg from Casa Grande to/from Phoenix overlaps with portions of both the I-10 Tucson to Phoenix Key Commerce Corridor and Corridor Profile.

UPRR's Nogales Subdivision is also a Key Commerce Corridor and Corridor Profile overlapping with international freight rail services into and out of Mexico along the I-19 Tucson to Nogales corridor.

Rail System Performance

In addition to the information provided in the main body of Working Paper 2, the following rail system performance issues are notable:

CANAMEX. The on-going CANAMEX Corridor evaluations are developed to improvements to Arizona's freight rail system are envisioned to improve north to south capacity, connectivity, and economic competitiveness within the state.

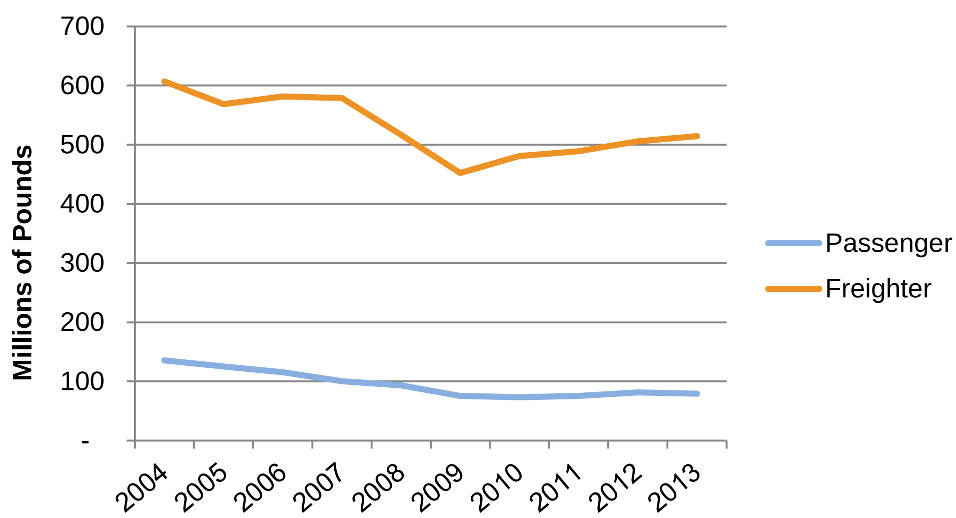
Rail grade crossings. The state's rail system also includes at-grade crossing conflicts between freight (and passenger) trains and vehicles that occur in many locations across Arizona, including Phoenix, Tucson, Flagstaff, Nogales, among others. Grade separation strategies to eliminate or reduce these conflicts will enhance the potential expansion of freight rail infrastructure and services in the future.

Terminal Capacity Limitations. UPRR's Harrison Street Classification Yard located in downtown Phoenix has limited capacity to serve existing goods movement let alone the potential for expanded future movements. Similarly, both the BNSF Mobest and El Mirage Yard's face capacity constraints. The Mobest Yard, located in Phoenix, has Interstate 10 passing over the yard on elevated structures, and is surrounded by urbanized development. The BNSF Auto Distribution Facility at El Mirage is located east of Grand Avenue near Greenway Road. The congestion at the adjacent major intersections is a concern to the operation of this facility.

Air Cargo Traffic Statistics

Figure 69 illustrates the continued downward trend in cargo carried to and from Arizona on passenger aircraft. In 2013, 13 percent of Arizona's air cargo was carried on passenger aircraft. A partial rebound in air cargo volume has occurred, but has been focused within the freighter sector.

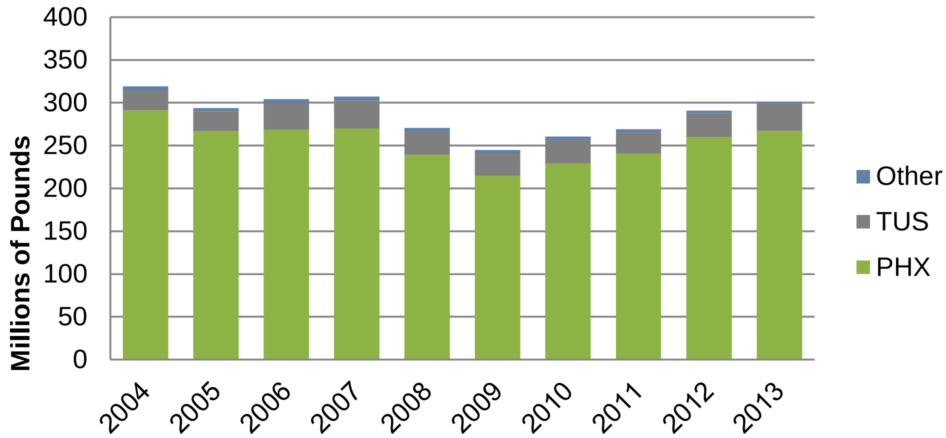
Figure 69: Air Cargo Carried to and from Arizona by Aircraft Configuration



Source: Bureau of Transportation Statistics (2014)

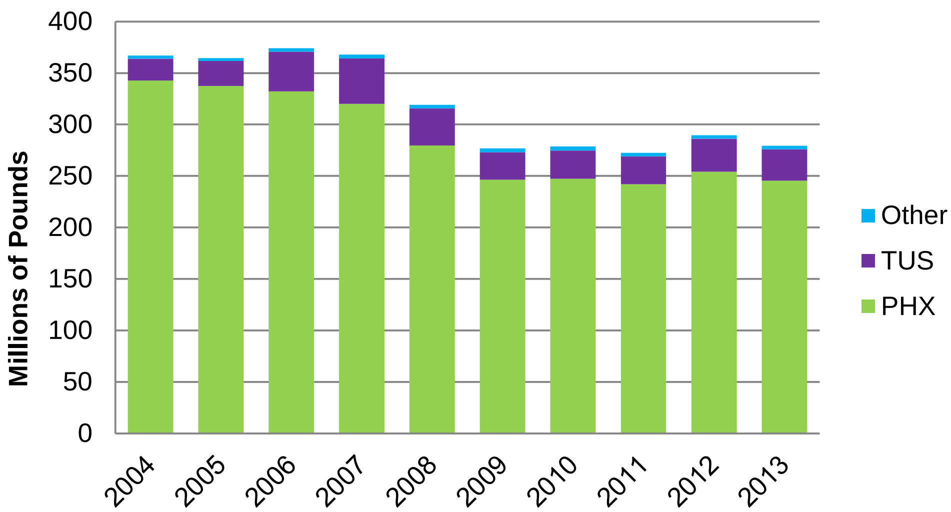
Eleven airports contribute to the total volume of air cargo exported and imported throughout Arizona (Figure 70 and Figure 71). Most of the state's air cargo (89 percent) is processed through PHX (Bureau of Transportation Statistics [BTS] 2014), with TUS accounting for another 10 percent. The remaining one percent of freight is processed through Yuma International Airport (NYL), Flagstaff Pulliam Airport (FLG), and Lake Havasu City Airport (HII).

Figure 70: Air Cargo Exports from Arizona Airports



Source: Bureau of Transportation Statistics (2014)

Figure 71: Air Cargo Imports to Arizona Airports



Source: Bureau of Transportation Statistics (2014)

Phoenix also handles the largest mail volumes; in 2004, it received 92.8 percent of mail arriving into Arizona by air. By 2013, the percentage of mail handled through PHX had increased to 99.7 percent. Phoenix's share of mail exports is also high, with 96.7 percent in 2004, increasing to 99.5 percent in 2013.

Figure 72 and Figure 73 demonstrate that the integrators,[71] namely Federal Express Corporation (FedEx) and United Parcel Service (UPS), are the dominant carriers of air cargo at PHX.

Figure 72: Phoenix Air Cargo Exports by Carrier

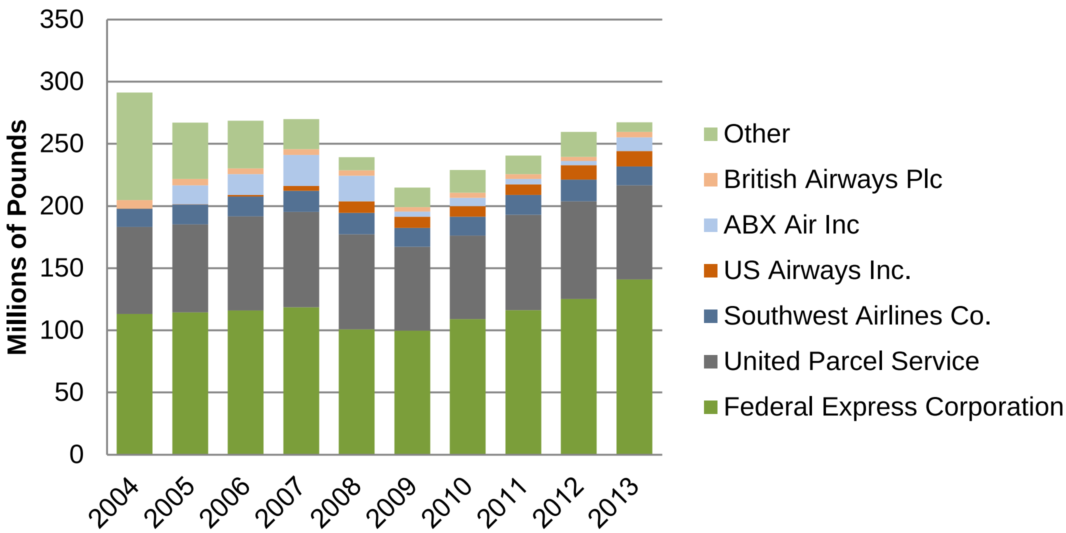
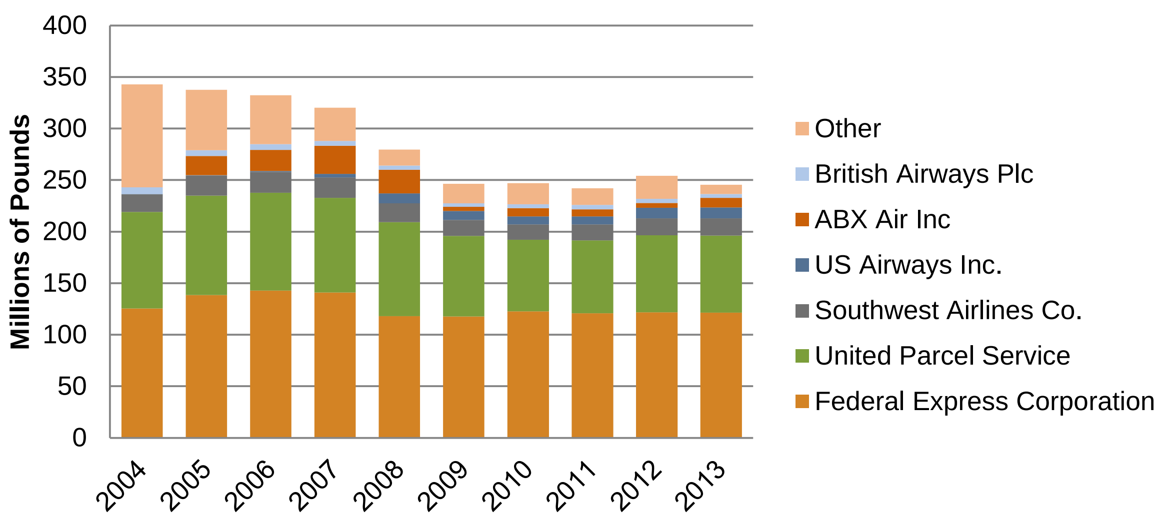


Figure 73: Phoenix Air Cargo Imports by Carrier



In 2004, FedEx had a 38 percent share of exports, but by 2013 this had grown to 52.7 percent. UPS's share remained static at 24 percent. FedEx's import share grew from 36 to 49 percent, and UPS also increased from 27 to 30 percent. Over the same time period, FedEx and UPS export

[71] The air freight industry can be characterized as two organizational structures: integrators, who own all assets of production from shipper to consignee, and non-integrators, who forward, carry and deliver cargo.

volumes grew 10 and 12 percent, respectively, for exports, but import volumes declined by 3 and 20 percent, respectively.

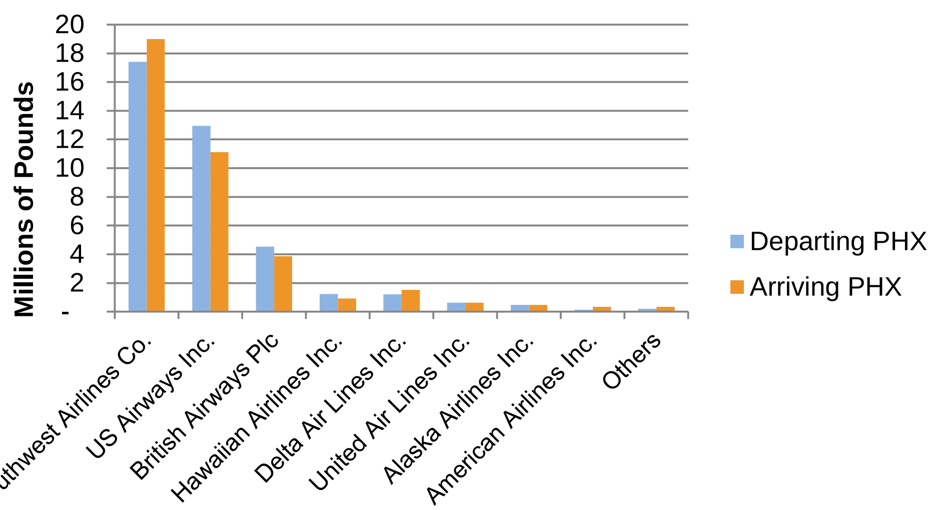
The reason that Phoenix air cargo volume is dominated by FedEx and UPS is that it is utilised as a mini hub. This mini hub has a number of different operations:

1. Small aircraft depart from other Arizona airports including Lake Havasu (airport code HII), Flagstaff (FLG) and Yuma (NYL) either once or twice a day that carry cargo to connect with outgoing flights to the integrators main and regional hubs. These small feeder flights also carry cargo back to these airports, typically during the early morning.
2. A sortation facility that sorts cargo and loads to aircraft serving either a regional or main hub. For example a piece of cargo travelling to San Francisco from Phoenix with FedEx is most likely to fly to FedEx's western regional hub at Oakland, CA. Cargo destined for the East coast is more than likely to transfer through either the main hub at Memphis or a secondary hub at Indianapolis.
3. A ground distribution operation that connects incoming and outgoing flights with the integrator's ground transport network. Cargo originating and destined for Phoenix and surrounding towns and cities, will typically be transported to and from the airport by truck.

In 2013, ABX Air Inc., operating on behalf of DHL, had 1,023 freighter movements at Phoenix, while FedEx had 5,047 and UPS 2,553.

Cargo carried on passenger aircraft is dominated by Southwest Airlines, with 47 percent of all cargo carried on passenger aircraft to and from Phoenix (Figure 74).

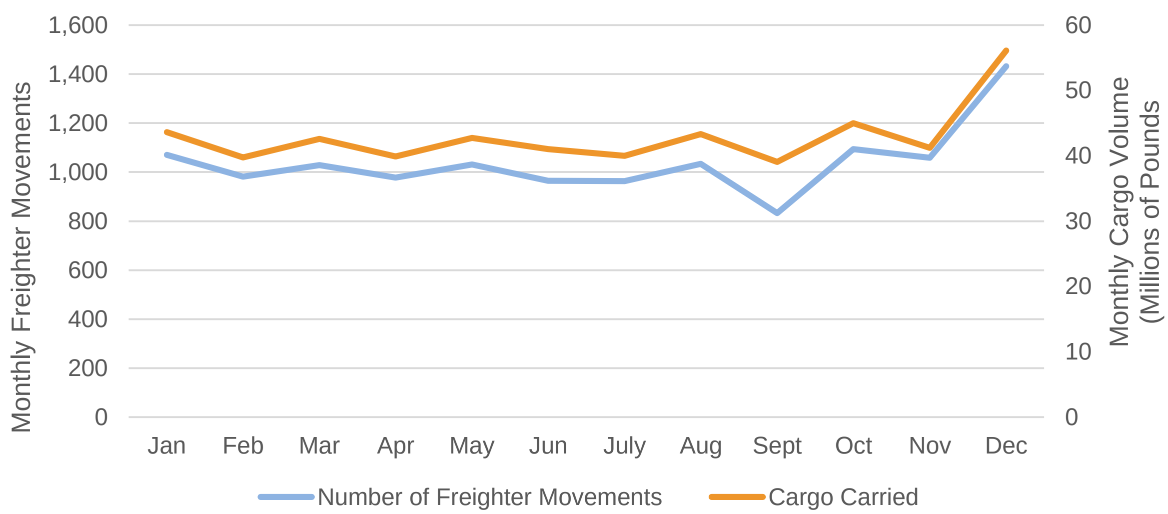
Figure 74: Cargo Carried on Passenger Aircraft to and from Phoenix



Christmas brings additional pressures to the air cargo system. With the growth in online shopping, an increasing number of goods are being dispatched through the integrators' air cargo network. Figure 75 details the number of freighter movements into and out of Arizona during

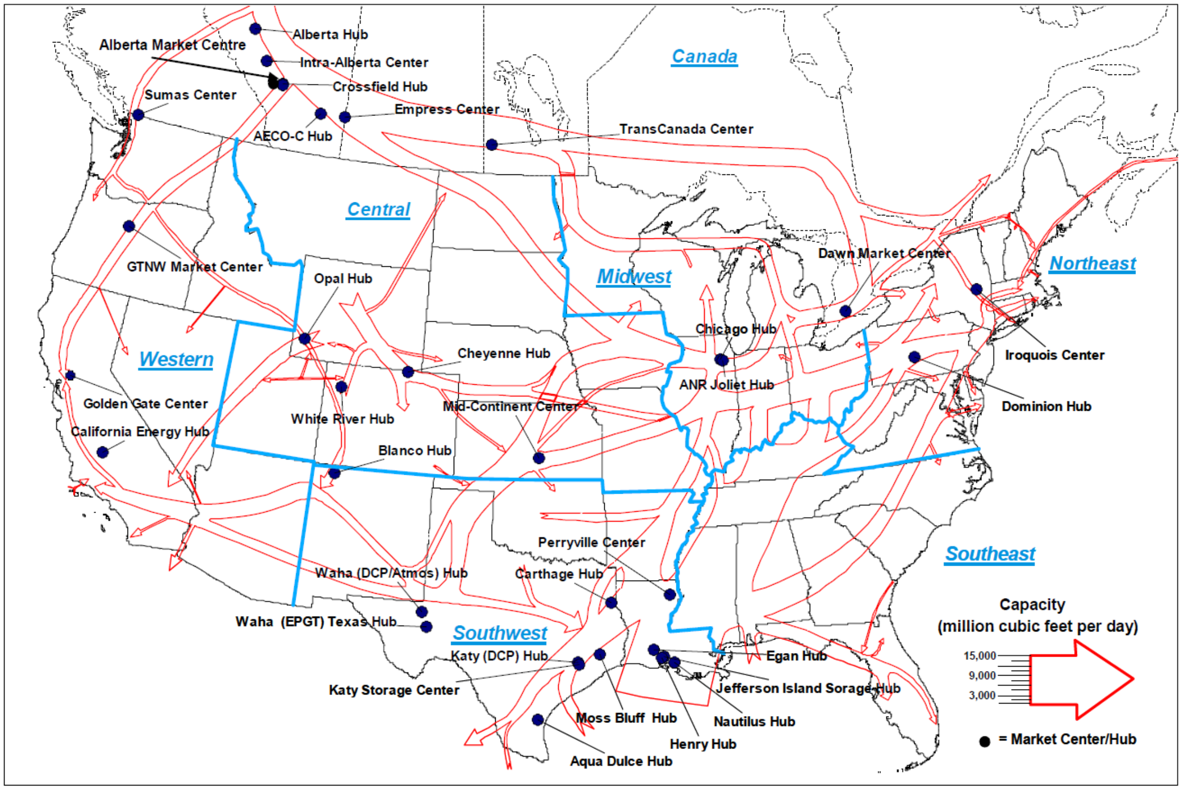
2013 and the cargo carried each month. This Christmas pressure in 2013 resulted in the air cargo system having to accommodate an additional 400 freighter movements above the typical normal monthly level of just over 1,050.

Figure 75: 2013 Freighter Movements



Natural Gas Centers/Hubs Relative to Natural Gas Transportation Corridors, 2008

Figure 76: Natural Gas Centers/Hubs Relative to Natural Gas Transportation Corridors, 2008



DCP = DCP Midstream Partners LP; EPGT = Enterprise Products Texas Pipeline Company.
Note: The relative widths of the various transportation corridors are based upon the total level of interstate pipeline capacity (2008) for the combined pipelines that operate on the generalized route shown.
Source: Energy Information Administration, GasTran Gas Transportation Information System, Natural Gas Market Hubs Database, December 2008.

Natural Gas Distribution Networks

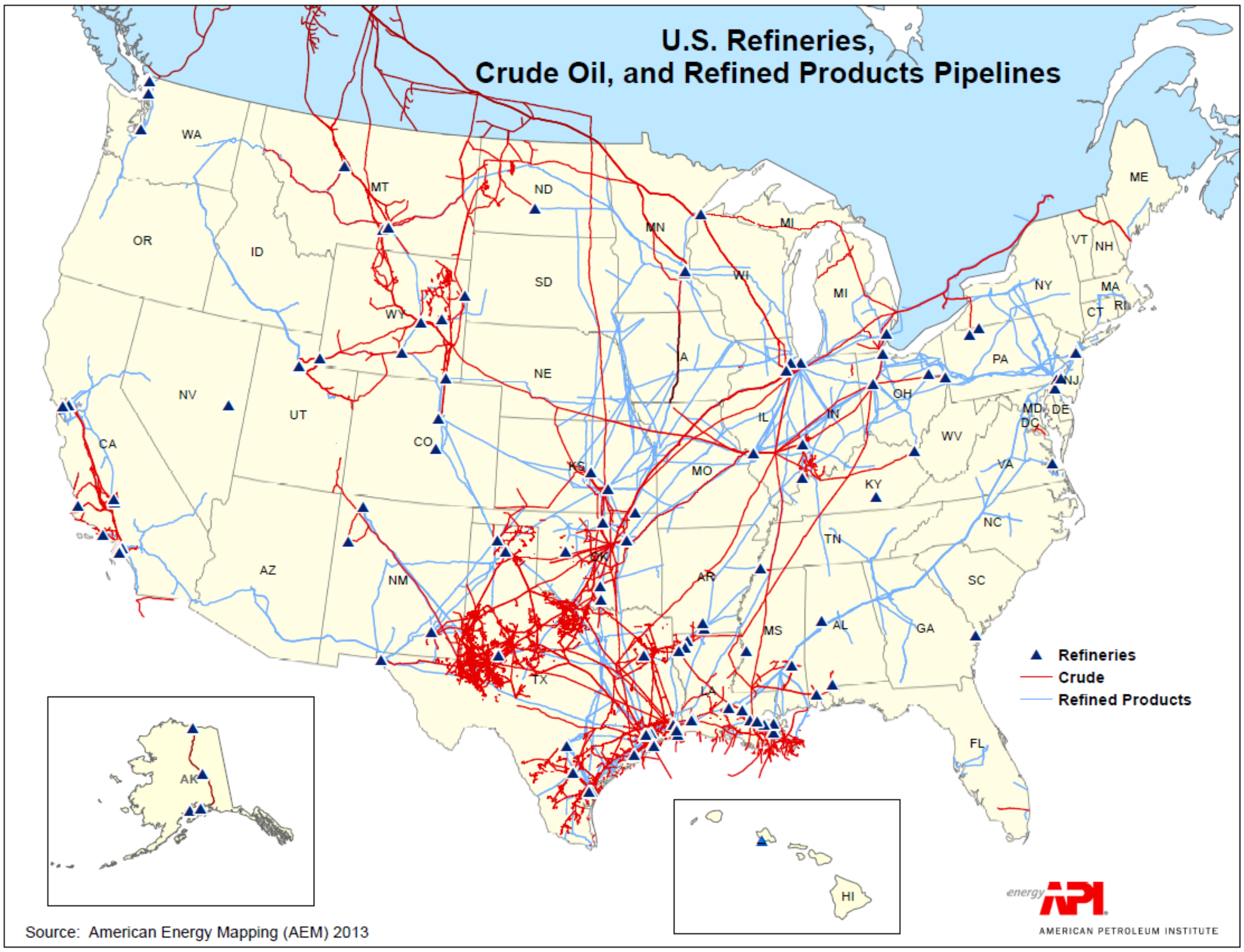
Arizona's natural gas distribution networks are fed mostly by El Paso Natural Gas Company's interstate pipelines. The small remainder is delivered by the Transwestern and Questar pipelines (ACC 2015). These gas distributors are referred to as local distribution companies (LDCs).

Crude Oil Pipelines and Refined Products Pipelines

Crude Oil Pipelines and Refined Products Pipelines

An overview of U.S. refineries, crude oil pipelines, and refined products pipelines is provided in Figure 77:

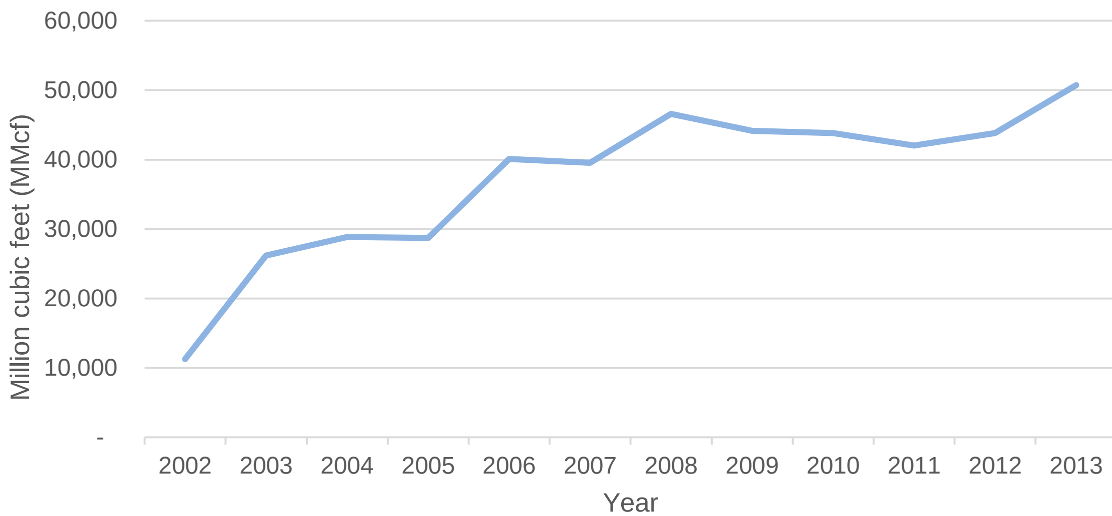
Figure 77: U.S. Refineries, Crude Oil, and Refined Products Pipelines



Source: American Energy Mapping (2013)

In the natural gas sector, we can see (in Figure 79) that new gas transmission pipelines in Arizona have been developed to export natural gas to Mexico. Figure 78 shows the net volume of natural transported by pipeline to Mexico. It is very likely that this trend will continue into the near future based on shale gas production forecasts and the energy market in Mexico.

Figure 78: ArizonaNet Natural Gas Export to Mexico



Source: U.S. Energy Information Administration (2015)

Arizona's gas transmission pipeline capacities are shown in Figure 79 and Figure 80. The tables also show how that capacity has changed over time.

Figure 79: Natural Gas Pipeline Capacity from Arizona to Other States and Mexico, 2008–2014

Delivering Pipeline	To	2014	2013	2012	2011	2010	2009	2008
		In millions of cubic feet per day (MMcf/d)						
El Paso Natural Gas Co.	Cochise, Mexico	185	185	185	—	—	—	—
El Paso Natural Gas Co.	California	3,390	3,390	3,390	3,390	3,390	3,390	3,390
El Paso Natural Gas Co.	Sonora, Mexico	261	261	261	261	261	261	261
Mohave Pipeline Co.	California	400	400	400	400	400	400	400
North Baja Pipeline Co.	California	500	500	500	500	500	500	500
Questar P L Co.	California	80	80	80	80	80	80	80
Sierrita Gas Pipeline	Sasabe, Mexico	261	—	—	—	—	—	—
Southwest Gas Trans. Co.	Nevada	294	294	294	294	294	294	294
Transwestern Pipeline Co.	California	1,317	1,317	1,317	1,317	1,317	1,317	1,317
	Total	**6,688**	**6,427**	**6,427**	**6,242**	**6,242**	**6,242**	**6,242**

Source: U.S. Energy Information Administration (2015)

The most notable recent development in the pipeline industry is Sierrita Gas, which came on-stream in 2014 and exports gas to Mexico. This new line shows the growing trend to export to Mexico in larger and larger quantities. El Paso Natural Gas Company also expanded a lateral pipeline, which came on-stream in 2012 and provides natural gas to power generation projects in Mexico.

Figure 80: Natural Gas Pipeline Capacity to Arizona from Other States, 2008–2014

Delivering Pipeline	From	2014	2013	2012	2011	2010	2009	2008
		In millions of cubic feet per day (MMcf/d)						
El Paso Natural Gas Co.	New Mexico	4,578	4,578	4,578	4,578	4,578	4,578	4,578
North Baja Pipeline Co.	California	614	614	614	614	614	614	614
North Baja Pipeline Co.	California	81	81	81	81	81	—	—
Questar P L Co.	New Mexico	87	87	87	87	87	87	87
Transwestern Pipeline Co.	New Mexico	1,210	1,210	1,210	1,210	1,210	1,210	1,210
	Total	**6,570**	**6,570**	**6,570**	**6,570**	**6,570**	**6,489**	**6,489**

Source: U.S. Energy Information Administration (2015)

For gas coming into Arizona, Figure 80 shows that the North Baja Pipeline expanded its services. This new lateral pipeline (the Yuma Lateral) came on-stream in 2010 primarily to supply gas to a power generation plant in Arizona as well as potential future power generation projects. This lateral is configured to transport domestic gas from California and regasified, liquefied natural gas from Mexico.