Arizona Truck Parking Supply, Demand, and Needs Analysis

Working Paper 2: Identification of Truck Parking Demand Factors

Prepared for:

Arizona Department of Transportation

Prepared by:

CPCS

In association with:

HDR Engineering, Inc.

American Trucking Research Institute

Solutions for growing economies

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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.

Contact

Questions and comments on this working paper can be directed to:

Donald Ludlow
Project Director
T: +1.202.772.3368
E: dludlow@cpcstrans.com

Alex Marach
Project Manager
T: +1.920.737.2980
E: amarach@cpcstrans.com

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Acronyms / Abbreviations

ADOT	ARIZONA DEPARTMENT OF TRANSPORTATION
AOBRD	AUTOMATIC ON BOARD RECORDING DEVICE
ATRI	AMERICAN TRANSPORTATION RESEARCH INSTITUTE
AV	AUTONOMOUS VEHICLE
AZTDM	ARIZONA STATEWIDE TRAVEL DEMAND MODEL
CV	CONNECTED VEHICLES
ELD	ELECTRONIC LOGGING DEVICES
FMCSA	FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION'S
FY	FISCAL YEAR
HOS	HOURS OF SERVICE
JIT	JUST-IN-TIME
MAP-21	MOVING AHEAD FOR PROGRESS IN THE 21ST CENTURY ACT
NHTSA	NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
OOIDA	OWNER OPERATOR INDEPENDENT DRIVERS ASSOCIATION
V2I	VEHICLE-TO-INFRASTRUCTURE
VMS	VARIABLE MESSAGE SIGNS
VMT	VEHICLE MILES TRAVELED

Executive Summary

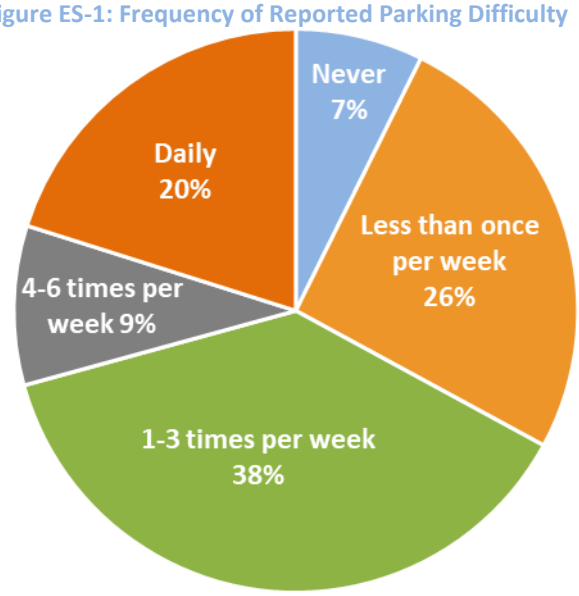
Understanding the specific needs and concerns of the trucking industry is an important step toward crafting effective truck parking solutions. To gather the information needed to inform this and subsequent steps in the study, the research team conducted a series of trucking industry consultations and conducted an online survey. The survey and consultations, combined with a literature review on parking demand factors, confirm that truck drivers often experience difficulty finding safe truck parking spaces in Arizona, and parking shortages are likely to increase in the future. These shortages can negatively affect highway safety, infrastructure condition, public safety, and quality of life.

Parking Needs and Concerns

Trucking industry executives revealed their top two truck parking concerns are an overall lack of parking capacity, especially at warehouses and distribution centers, and a lack of information about parking. Information about truck parking is a particular problem when drivers need to change plans in response to unexpected changes along their route, such as weather or congestion. These parking and information shortages have two impacts on business: first they decrease driver job satisfaction, which executives viewed as a threat to driver retention in an already tight labor market. Second, parking in undesignated areas exposes drivers to a higher likelihood of either theft or cargo damage.

67 percent of drivers reported difficulty finding parking in Arizona at least one to three times per week.

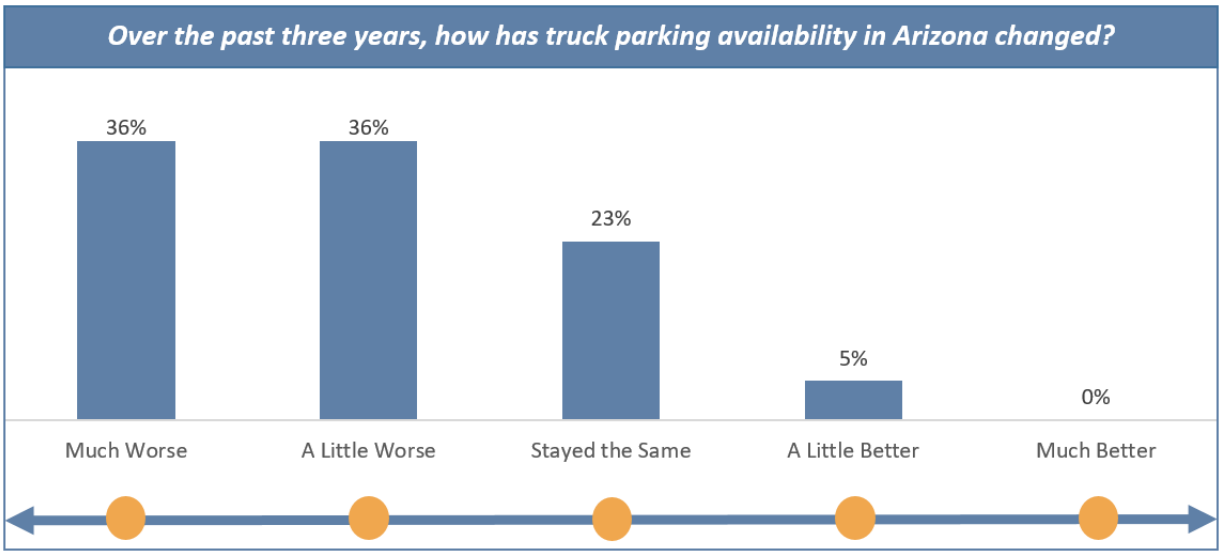
Figure ES-1: Frequency of Reported Parking Difficulty



Source: CPCS Survey.

As shown in Figure ES-1, 93 percent of drivers reported some degree of difficulty finding parking in Arizona. In terms of geography, 49 percent of drivers said that finding parking was a problem primarily in urban areas such as Phoenix, Tucson, or Flagstaff, while another 42 percent said that finding parking was a problem everywhere in Arizona. Additionally, 72 percent of truck drivers said that truck parking availability has gotten worse over the past three years, compared to only five percent responding that truck parking had gotten better.

Figure ES-2: Changes in Truck Parking Availability Over the Past Three Years



Source: CPCS Survey.

Truck drivers that have trouble finding truck parking encounter three major consequences:

- **Spending time searching for parking**: 22 percent of drivers spent 16 to 30 minutes and 29 percent spent over 31 minutes searching for parking in Arizona.
- **Stopping their workday early to find a parking spot**: 63 percent of drivers give up more than 30 minutes to secure a parking space each time they park in Arizona.
- **Parking in undesignated areas:** 50 percent of drivers park in an undesignated space such as a vacant lot, highway ramp, or local street in Arizona once a week or more.

Truck parking issues make trucking in Arizona less efficient, reduce highway safety, degrade infrastructure condition, and decrease the quality of life for truck drivers and local residents.

Parking Demand Factors

The demand for truck parking is affected by a combination of public and private sector factors. Identifying and describing the factors that drive parking demand helps establish the context for truck parking, as well as identify the factors that may affect truck parking in the future.

Baseline truck parking demand is defined largely by the Federal Motor Carrier Safety Administration's Hours of Service (HOS) rules. Under these rules, each driver is limited to a total of 14 hours of on duty time each day and a maximum of 11 hours of drive time. After 14 hours on duty or 11 hours of driving, whichever comes first, a driver is required to take a minimum 10 hour rest break before driving again. HOS regulations also specify that drivers may not drive for more than eight hours without a minimum of a 30 minute rest break.

The sum of HOS rules applied to millions of truck movements forms the baseline for truck parking demand in Arizona.

Recent changes to the process truck drivers use to record their HOS have increased the demand for truck parking. In the past, paper logbooks gave drivers some "wiggle room" in reporting driving times, because paper logbooks monitored and documented driving time using 15 minute time blocks. This allowed truck drivers 15 minutes to look for truck parking even after they had technically run out of drive-time (e.g. 11 hours ends at 7:00 p.m., but the log is good until 7:15 p.m.). Paper logs also allowed for more substantial edits, which could be used to hide the time spent driving over allowed HOS.

However, most drivers are now required to use Electronic Logging Devices (ELDs) to record their HOS. ELDs interface directly with a truck's electrical system, and automatically generate HOS records based on truck operations. The automatic recording and tamper-proof nature of ELDs mean that drivers no longer have flexibility when trying to find parking at the end of their day, and must stop earlier to find and secure a parking space. As a result, most drivers believe that the implementation and enforcement of ELD requirements will increase parking demand and have a negative impact on parking availability in Arizona

85 percent of truck drivers believe the ELD mandate will cause Arizona's truck parking problems to become worse.

Other economic factors affecting the demand for truck parking include:

- Truck traffic volumes and tonnage are forecasted to increase. Truck tonnage is forecasted to nearly double between 2013 and 2040. An increase in tonnage will result in a further increase in truck traffic, and greater demand for truck parking.
- An increase in warehouses and distribution centers will require truck drivers to pick up or deliver loads at specific scheduled times, and usually do not allow for parking on site. As a result, truck drivers who need to wait for a scheduled pickup or delivery time must find truck parking elsewhere.

Arizona currently experiences parking shortages and parking problems, particularly around urban areas. Demand factors such as government regulation, trends in economic factors, increased truck volume, and the growth of retail and wholesale sectors suggest Arizona's truck volumes and parking demand are likely to increase in the future, exacerbating existing parking shortages.

1 Introduction

1.1 Background and Objectives

The Arizona State Freight Plan identified inadequate truck parking facilities as a major issue affecting the safety and efficiency of freight movement in Arizona, particularly on I-17 between Phoenix and Flagstaff, and on I-10 between Tucson and the California border. This issue was identified through consultations with truck drivers and trucking companies, as well as a growing body of state and national research on truck parking issues.

A lack of adequate truck parking often prompts truck drivers to park on highway shoulders, entrance or exit ramps, vacant property, or local surface streets. These parking behaviors can negatively impact highway safety, infrastructure condition, public safety, and quality of life. Existing truck parking shortages may be exacerbated by current trends and future changes to freight policies. For example, trucking industry executives in Arizona expect parking conditions to deteriorate in the future as Electronic Logging Devices (ELD) are fully implemented, and as the volume of truck traffic increases faster than the development of dedicated truck parking spaces.

The objective of this project is to provide an in-depth analysis of the truck parking issues identified in the Arizona State Freight Plan. The plan will provide the groundwork to enable the Arizona Department of Transportation (ADOT) and its stakeholders to develop strategies to address inadequate truck parking.

This study assesses current truck parking conditions and identifies gaps between truck parking supply and demand, defines infrastructure and policy needs, and proposes potential capacity and technology solutions.

Through the use of real time truck parking data and consultations with the trucking industry, law enforcement, and truck stop operators, this study will identify where trucks are parking in Arizona and how the ELD mandate may impact Arizona. Ultimately, the study will identify the gap between the supply and demand for safe truck parking spaces, associated infrastructure and policy needs, and potential capacity and technology solutions to resolving them.

1.2 Project Structure

The Arizona Truck Parking Supply, Demand, and Needs Analysis will be developed in two broad phases, with a total of six work tasks (Figure 1-1). The present Working Paper is part of Phase 1 and is the output of Task 2: Identify Truck Parking Demand Factors.

Figure 1-1: Project Work Plan

1.3 Purpose of this Working Paper

The purpose of this Working Paper is to identify the social, economic, and geographic factors that affect truck parking demand in Arizona. In order to identify these factors, this Working Paper seeks to answer the following key questions:

- What are the primary truck parking concerns of the trucking industry in Arizona?

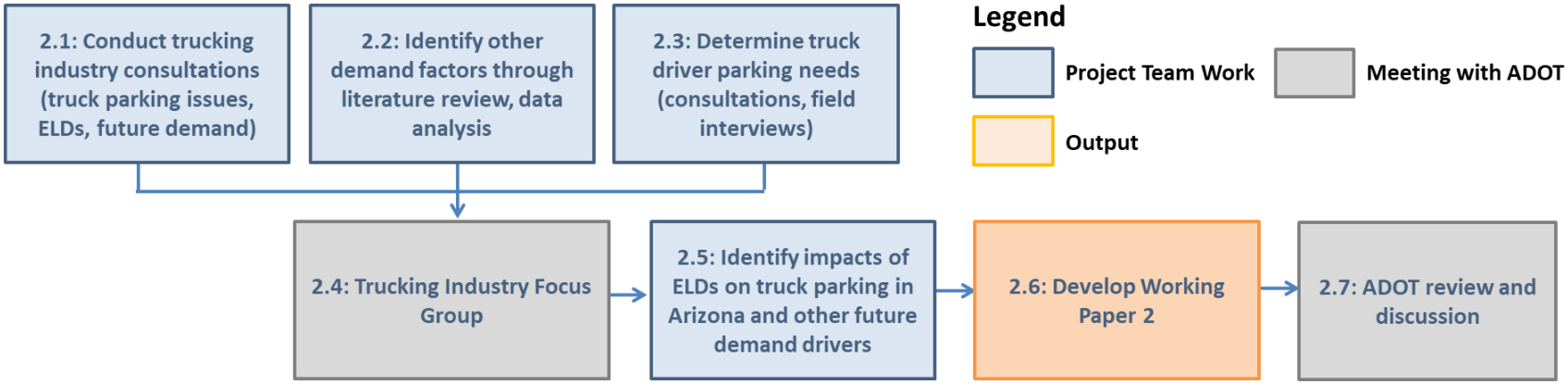
- What demand factors, including freight activity, traffic volume, hours of service (HOS) regulations and other issues affect truck parking demand statewide?
- What is the expected impact of the ELD on truck parking in Arizona?
- What are the truck drivers' parking needs and how do these needs differ by long haul and short-haul (urban) operations?
- What other factors are expected to affect truck parking availability in the future?

This Working Paper is also intended to provide ADOT with an overview of progress to date and to solicit comments and other feedback on the structure and content of this component part of what will become the final report.

1.4 Methodology

This working paper was prepared using consultations with trucking industry representatives, a survey of truck drivers, a literature review, and analyses of truck traffic and economic data. Key sources of information include an online survey and ADOT's truck traffic records. Figure 1-2 provides an overview of Task 2's workflow.

Figure 1-2: Task 2 Work Plan



1.5 Limitations

Some of the findings in this report are based on the analysis of third-party data. While CPCS makes efforts to validate data, CPCS cannot warrant the accuracy of third-party data.

2 Current Parking Needs and Concerns

Key Messages

Seventy-two percent of truck drivers believe that parking problems in Arizona have gotten worse in the past three years. Specific problems include drivers spending time searching for parking, drivers stopping early to secure parking, and drivers parking in undesignated or illegal areas.

Today, 67 percent of truck drivers report difficulty finding parking in Arizona at least once a week, and 63 percent of drivers give up more than 30 minutes of drive time on average to secure parking in Arizona. Additionally, almost 50 percent of drivers report parking in undesignated areas at least once a week. Driver surveys suggest that these parking problems are more common in urban areas such as Phoenix and Tucson.

2.1 Introduction

Understanding the specific needs and concerns of the trucking industry is an important step toward crafting effective truck parking solutions. To further develop this understanding, this section seeks to answer the following questions:

- What are the truck drivers' parking needs, and how do these needs differ between long haul and short-haul operations?
- What are the primary truck parking concerns of the trucking industry in Arizona?

2.2 Consultation and Survey Methodology

In order to develop a greater understanding of truck parking needs in Arizona, we conducted two kinds of outreach: consultations with trucking industry representatives and online surveys of truck drivers.

Consultations with industry representatives included five phone and one email consultation. We also vetted our observations during a meeting of the Arizona Truck Parking Advisory Group. Participants included executives from trucking companies, a trucking insurance representative, and a driver training school operator. The purpose of these consultations was to obtain a nuanced understanding of industry executives' concerns. In addition to consulting with trucking industry executives through interviews and with industry leaders who sit on the Arizona Truck Parking Advisory Group, we developed an online survey tool to collect information from a larger group of truck drivers.

The research team created and administered the online survey of truck drivers using SurveyMonkey, an online survey application tool. To reach a broad potential survey pool, we distributed the survey to a wide range of truck drivers through multiple channels. The Arizona Trucking Association distributed a survey link to its members via email. The Owner Operator Independent Drivers' Association (OOIDA) announced the survey via multiple mentions on their satellite radio show *Land Line Now,* an article in their daily email digests, and an article on their *Land Line Magazine* website. Together, these two outreach efforts ensured that the research team accounted for the needs and views of both company-employed and independent truck drivers. In total, 170 drivers responded to the survey, with 164 confirming they park in Arizona.

2.3 Concerns of Industry Representatives

Industry stakeholders discussed both current and future truck parking concerns, including:

- An overall lack of parking capacity in Arizona, particularly around urban areas, and the closing of rest stops.
- Difficulty finding parking "on the fly" when a driver's route or plan was disrupted due to inclement weather, equipment malfunctions, or extended loading and unloading.
- A lack of information about parking locations and parking availability, which makes "on the fly" planning more difficult.
- Limited parking availability on I-17 between Phoenix and Flagstaff and on I-10 between Tucson and the California border.
- Parking is not available at or around many warehouses or distribution centers in Arizona.

Looking toward the future, industry executives also expressed concern that continued development in urban areas like Phoenix would eventually cause the closure of existing truck parking facilities like truck stops. A similar concern was that zoning regulations would prevent the development of new parking facilities close to urban areas. Another zoning concern was the growth of warehousing with little to no truck parking on-site, on adjacent roadways, or near warehousing clusters.

Executives also shared two insights on how parking shortages affected their operations. The first and most commonly mentioned impact of parking shortages was decreased driver satisfaction. Satisfaction may decrease because of the stress and lost productivity resulting from insufficient truck parking. The decrease in driver satisfaction contributes to driver turnover, further exacerbating the truck driver shortage and high rates of driver turnover. Any phenomena that decreases driver satisfaction represents a potential threat to a carrier's operations because it reduces their ability to retain drivers and increases costs.

A second impact mentioned by industry was the cargo theft and damage resulting from trucks parking in inappropriate areas, such as highway shoulders or unlit vacant lots. An insurance executive serving the trucking industry noted that thieves are following high-value cargo for longer distances, and parking in unlit areas could expose drivers to a greater likelihood of cargo theft. Conversely, the insurance industry identified parking in well-lit established facilities, such as rest areas or truck stops, as a measure that could reduce the potential for cargo theft. An additional concern was trucks parking on uneven or sloped surfaces such as the shoulders of

ramps, where loads were more likely to shift, or trucks were at risk for tipping over while parked.

Overall, the comments provided by trucking stakeholders align with issues present in other states. This provides an opportunity for ADOT to benefit from research and pilot projects in other states.

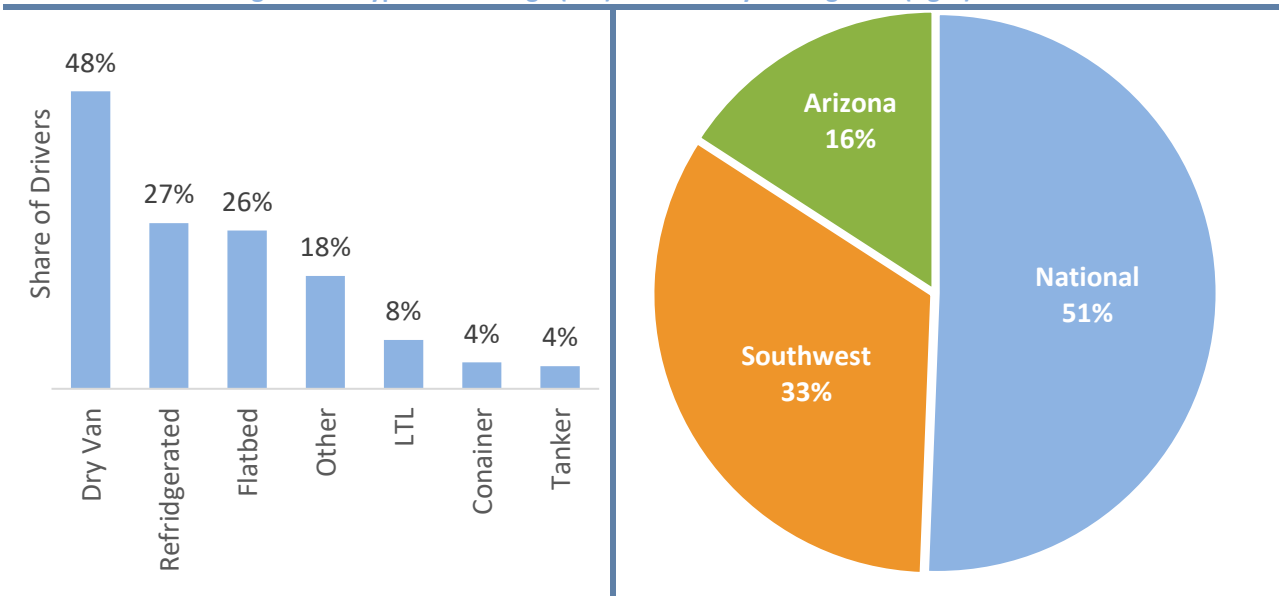
2.4 Driver Needs and Concerns

The research team developed an 18-question online survey to ask truck drivers how they used Arizona's truck parking and to identify truck parking problems and the solutions drivers believe would be best for the state.

2.4.1 Driver Groups

To start, the survey asked drivers about the type of truck they operate, such as dry van, flatbed, tanker, refrigerated, etc. The survey presented drivers with multiple kinds of trucking and provide an "other" answer for specialties such as oversize-overweight or livestock loads. The top three types of trucking were dry van, refrigerated, and flatbed, followed by "other", which were primarily oversize-overweight carriers. Figure 2-1 shows response rates for each type of trucking and the primary driving areas of the respondents. A little over half of respondents drove nationwide, while another 33 percent primarily drove in the southwest (defined as California, Arizona, New Mexico, Nevada, and Utah). The remaining 16 percent of respondents drove primarily within Arizona.

Figure 2-1: Type of Trucking* (left) and Primary Driving Area (right)



Source: CPCS Survey. *Note: For trucking type, the percentage shown lists the share of survey participants who indicated they performed that trucking type. Participants could select multiple types of trucking, and percentages shown add to greater than 100 percent.

2.4.2 Parking Needs: Length of Breaks

Truck drivers need parking for four major reasons: 1) legally-required 10+ hour rest breaks, 2) legally-required 30 minute rest breaks, 3) short-term breaks for meals and restrooms, and 4) staging for pickup or delivery at specific businesses.

Parking demand for both long and short rest breaks is driven by legal limits on how long truck drivers can operate. Parking demand resulting from staging for deliveries and pickup is driven by set pickup and delivery times for shipments. Trucks may only be able to access the facility during the scheduled time. This lack of access and on-site parking outside of narrow time windows forces trucks to park elsewhere while they wait for their scheduled appointments.

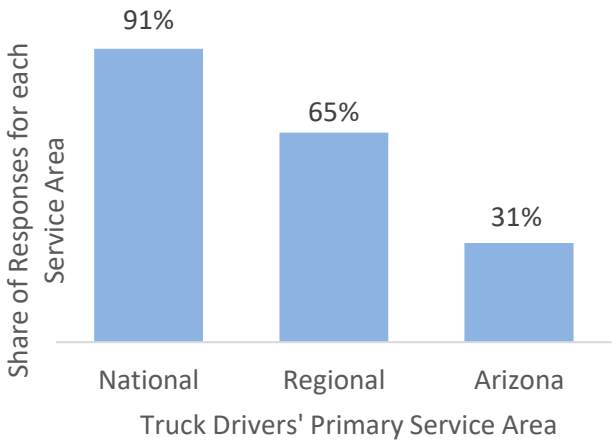
Beyond the four reasons truck drivers need parking, different types of truck drivers have specific reasons and needs for truck parking. Two broad types of drivers are used to illustrate differing reasons and need for truck parking:

- **Short Haul** truck drivers usually return to same home base location each day. Short haul trucking includes drivers traveling on fixed routes and drivers serving a relatively close geographic region. Since they usually return to the same starting location each day, a short haul drivers' need for longer overnight rest breaks is very limited. However, these drivers may still need parking for shorter breaks, as well as staging for deliveries and pickups, depending on the businesses they serve.
- **Long Haul** or "Over the Road" truck drivers usually cover thousands of miles across multiple states. Since these drivers travel long distances away from home for long periods of time, they are the most frequent users of overnight truck parking. However, they also need parking for shorter breaks as well as scheduled pickup and delivery times.

The survey asked drivers how they use truck parking in Arizona, and how often they need to find parking in the state. About 74 percent of all truck drivers indicated that they use Arizona's truck parking assets for legally-required long and short rest breaks. A smaller percentage of all drivers, 62 percent, said they used truck parking to stage for nearby deliveries and pickups.

Analyzing the use of truck parking in Arizona by the primary driving area revealed significant differences in how each geographically-defined group of drivers used truck parking. The biggest difference was in the reported use of truck parking for 10 hour rest breaks, where 91 percent of national drivers (long haul) reported using Arizona parking for these types of breaks, compared to only 31 percent of Arizona drivers (short haul). Figure 2-2 provides a visual comparison of how different groups of truck drivers reported their use of Arizona parking for 10+ hour rest breaks.

Figure 2-2: Rates of Parking Use for 10+ Hour Rest Breaks

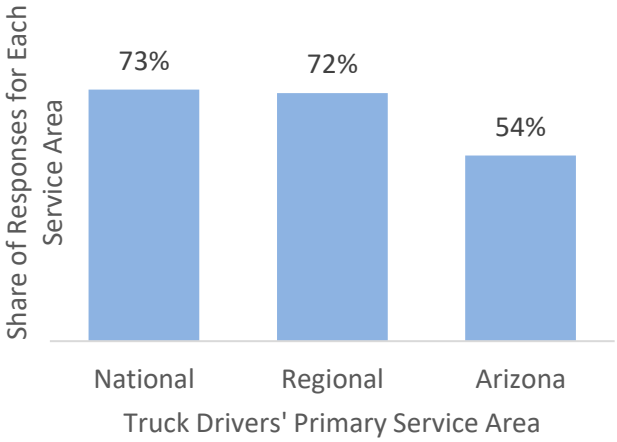


Source: CPCS Survey.

Truck drivers who used Arizona's truck parking to stage for scheduled pickup or delivery times showed a similar pattern. Namely, truck drivers operating nationwide and in the southwest reporter higher rates of parking due to staging than Arizona drivers (Figure 2-3).

The survey also asked truck drivers if they used Arizona's parking facilities for legally-required 30 minute rest breaks, and for shorter breaks for meals and bathrooms. In the case of these two types of shorter breaks, usage statistics were fairly similar across all groups, with national truck drivers reporting the highest rate of use for 30 minute breaks, and Arizona truck drivers reporting the highest rate of use for miscellaneous short breaks.

Figure 2-3: Rates of Parking for Staging for Scheduled Pickup and Delivery Times



Source: CPCS Survey.

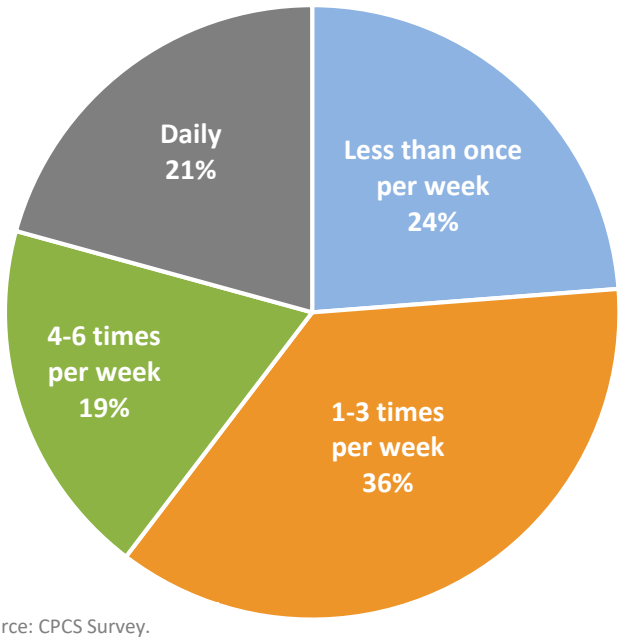
National and regional drivers are more likely to use Arizona's parking assets for overnight parking and staging for scheduled delivery windows than truck drivers that primarily operate in Arizona.

2.4.3 Parking Needs: Frequency of Parking in Arizona

The survey asked drivers how frequently they utilized truck parking in Arizona, and over 76 percent of respondents parked in Arizona one to three times per week or more. Figure 2-4 shows the overall parking frequency for all survey responses.

Similar to other questions, drivers indicated substantially different parking habits based on different driver service areas. National drivers parked in Arizona relatively rarely, most frequently saying they park in Arizona less than once per week or one to three times per week. Regional drivers had evenly distributed responses split between one to three times a week, four to six times per week, and daily. Drivers who operate primarily in Arizona split responses between parking either

Figure 2-4: Reported Arizona Parking Frequency for All Truck Drivers



Source: CPCS Survey.

daily or one to three times each week. The frequency of parking in Arizona is important to understanding other survey questions, such as the frequency a driver has difficulty finding parking or the frequency a driver parks in an undesignated location.

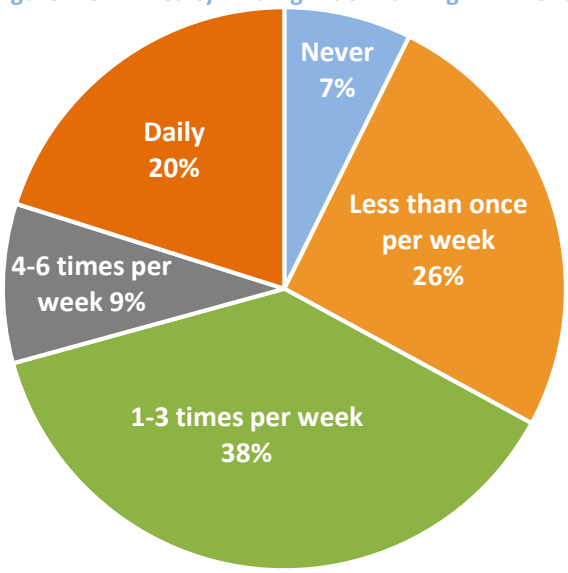
2.4.4 Truck Parking Issues in Arizona

In order to better understand truck parking issues in Arizona, the survey asked truck drivers about the frequency they encounter difficulty finding parking, locations where truck parking is difficult to find, and how truck parking has changed over the last three years.

Frequency of Truck Parking Problems

When asked about the frequency they experience problems finding truck parking in Arizona, 93 percent of truck drivers reported having problems finding parking in Arizona. Figure 2-5 shows the breakdown of the frequency truck drivers encounter problems finding parking in Arizona.

Figure 2-5: Difficulty Finding Truck Parking in Arizona



Interpreting the statistics in Figure 2-5 is complicated by the fact some drivers park in Arizona more frequently than others. The frequency of parking in Arizona sets an upper bound on the frequency a truck driver experiences parking problems. Therefore, the research team compared the frequency a truck driver parks in Arizona to the frequency the driver said they had problems finding truck parking, in order to develop a deeper understanding of truck parking problems in Arizona. The results of this analysis, organized by the frequency the driver parked in Arizona, are as follows:[1]

- **Less than once a week (39 respondents):** 72 percent reported problems finding parking **less than once a week**, 15 percent of these drivers reported "never" having problems finding parking, and 13 percent responded that they had problems finding parking in Arizona more frequently than once per week.
- **One to three times per week (60 respondents):** 63 percent reported problems finding parking **one to three times each week**. Additionally, 12 percent responded that they had difficulty finding parking less once per week and five percent said they never have problems finding truck parking. About 20 percent responded they had problems more than one to three times per week.
- **Four to six times per week (31 respondents):** 26 percent reported trouble finding parking **four to six times per week**, 42 percent reported trouble one to three times each week, 19 percent reported trouble less than once a week, and six percent responded that they never

[1] Numbers may not equal 100% due to rounding

have trouble finding parking. Only six percent responded they had problems finding parking more than four to six times per week.

- **Daily (34 respondents):** 62 percent of drivers reported problems finding parking **daily**, nine percent reported four to six times per week, 24 percent reported trouble one to three times each week, and six percent responded that they have trouble finding parking less than once a week or never.

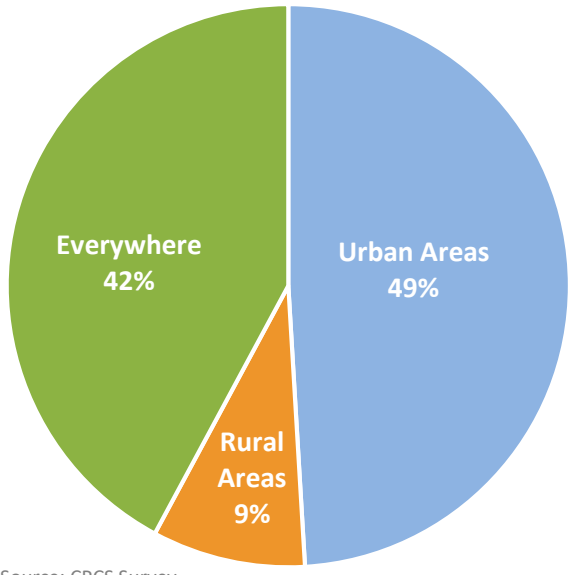
Analyzing the frequency that truck drivers experience problems finding truck parking in Arizona against the frequency they park in Arizona reveals that drivers often experience problems with nearly the same frequency that they park in Arizona. In total, almost 58 percent of respondents said they had problems finding truck parking with the same frequency as they park in Arizona.

The majority of drivers regularly experience problems finding parking in Arizona, regardless of how often they need parking.

Location of Truck Parking Problems

The survey also asked truck drivers where it was most difficult to find parking: urban areas, rural areas, or everywhere in Arizona. The survey included an opportunity to provide comments on specific locations where parking was a problem. Almost half of drivers said that parking in urban areas was a problem, while 42 percent said that parking was a problem everywhere in Arizona. Only nine percent of respondents said that parking was primarily a problem in rural areas. Figure 2-6 provides a visual breakdown of these responses.

Figure 2-6: General Location of Parking Problems



Source: CPCS Survey.

Forty drivers also provided written comments on areas in Arizona where they thought parking problems were the worst. The top problem areas identified by drivers were:

- Phoenix was mentioned in 24 responses (60 percent)
- Tucson was mentioned in 13 responses (33 percent)
- Flagstaff was mentioned in 11 responses (28 percent)

Other areas that were mentioned included I-17 between Phoenix and Flagstaff, Yuma, Nogales, Winslow, and Kingston.

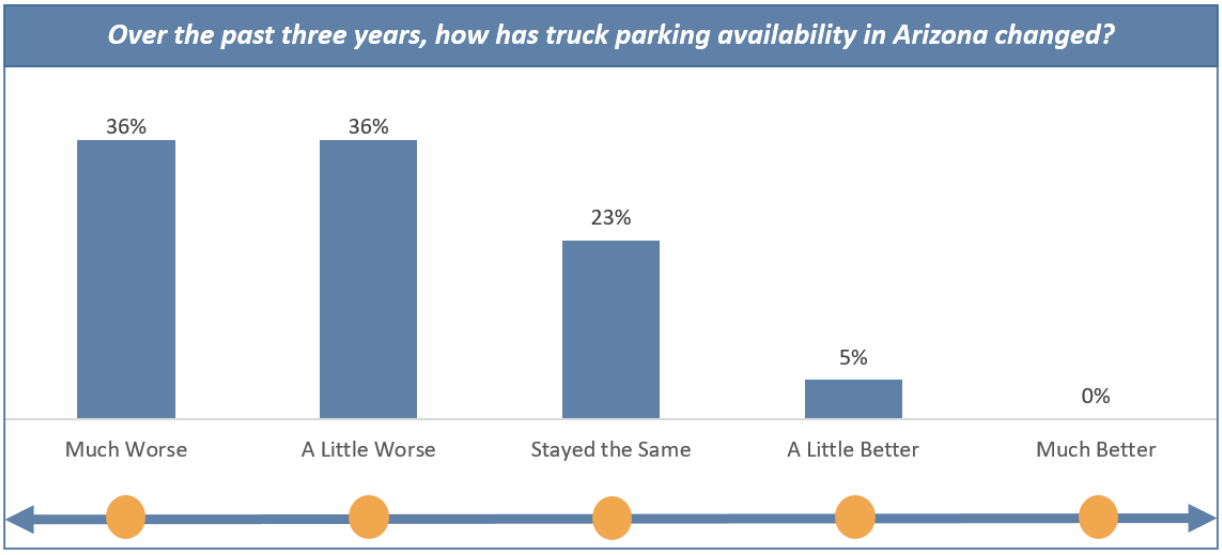
The combination of survey responses and written comments shows that there are problems with truck parking availability throughout Arizona, and these problems are particularly prevalent in urban areas, especially Phoenix.

Truck parking problems occur throughout Arizona, but problems are most frequent around major cities such as Phoenix and Tucson.

Historic Trend in Truck Parking Availability

Changes in overall truck parking problems can be difficult to measure, so drivers were also asked how truck parking availability in Arizona has changed over the past three years. 72 percent of drivers said that parking availability had gotten worse, 23 percent said it has stayed the same, and five percent said that it had gotten a little better (Figure 2-7).

Figure 2-7: Changes in Truck Parking Availability Over the Past Three Years



Source: CPCS Survey.

72 percent of drivers said that Arizona's truck parking availability has gotten worse in the past three years, with half reporting it is a little worse and half reporting it is much worse.

2.4.5 Consequences of Parking Problems

Arizona's truck parking shortage creates additional problems for truck drivers, because shortages mean that drivers must often spend driving time searching for parking, stop early to secure a spot, or park in undesignated areas. The survey measured drivers' experience with these consequences of truck parking shortages.

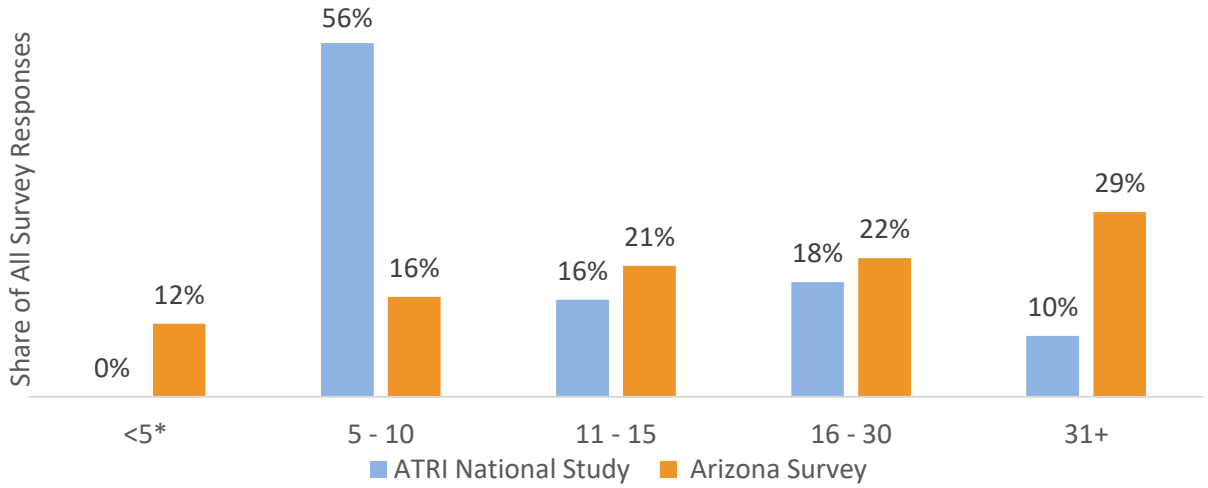
Searching for Parking

Increased time spent searching is the first challenge a driver may experience when trying to find parking in an area with limited availability. If a driver is unaware of where parking is available, they must spend time searching using either information resources such as websites, 511

services, mobile applications, or word of mouth, or they must drive to parking locations to visually search for parking. The time spent searching for truck parking is a cost to the driver because it reduces the amount of time the driver can spend making progress towards reaching their destination. Figure 2-8 shows how Arizona's parking search times break down by response category, as well as results from American Transportation Research Institute's (ATRI) Managing Critical Truck Parking Case Study –Real World Insights from Truck Parking Diaries.

When asked about the time spent searching for parking, 51 percent of survey respondents said they spend more than 16 minutes on average searching for parking, compared to 28 percent in the ATRI survey. Other surveys have found over half of respondents spending over 30 minutes searching for truck parking compared to 29 percent in Arizona.

Figure 2-8: Average Daily Search Time in Minutes for Parking in Arizona*



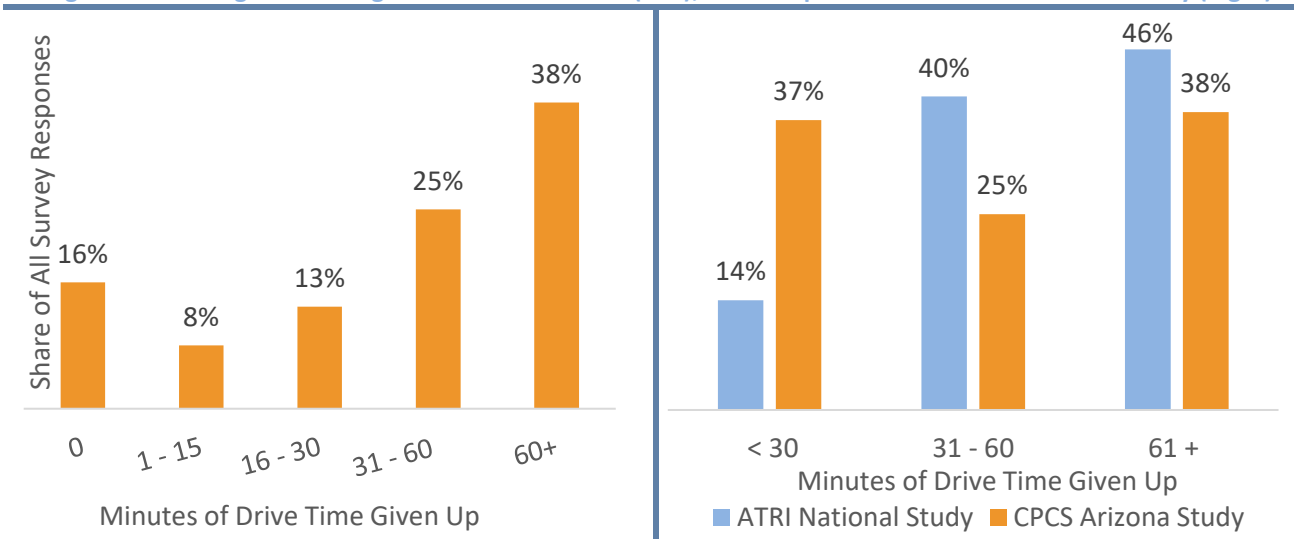
Source: CPCS survey; Managing Critical Truck Parking Case Study – Real World Insights from Truck Parking Diaries, American Transportation Research Institute, 2016.
*NOTE: ATRI's report omitted responses on search times less than five minutes.

Over half of drivers spend more than 15 minutes searching for parking when stopping in Arizona.

Stopping Early to Secure an Available Parking Spot

In addition to spending time looking for truck parking, truck drivers often have to stop driving early in order to ensure they are able to find parking before they run out of drive time. Parking availability often begins to diminish in the late afternoon and evening as many drivers seek parking for their 10 hour rest breaks. Since parking demand peaks during evening and nighttime hours, many drivers stop driving early to secure a parking spot. When drivers stop early, they may be "giving up" remaining available driving time. Figure 2-9 provides a breakdown of the average drive time forgone by truck drivers and a comparison of the survey of Arizona truck drivers to ATRI's nationwide survey. Some groups of responses have been combined for the comparison because Arizona's survey captured a greater level of detail of drive time given up below 30 minutes, and ATRI's survey captured beyond 60 minutes.

Figure 2-9: Average Remaining Drive Time in Arizona (Left), and Comparison of ATRI and Arizona Survey (Right)



Source: CPCS Survey; Managing Critical Truck Parking Case Study – Real World Insights from Truck Parking Diaries, American Transportation

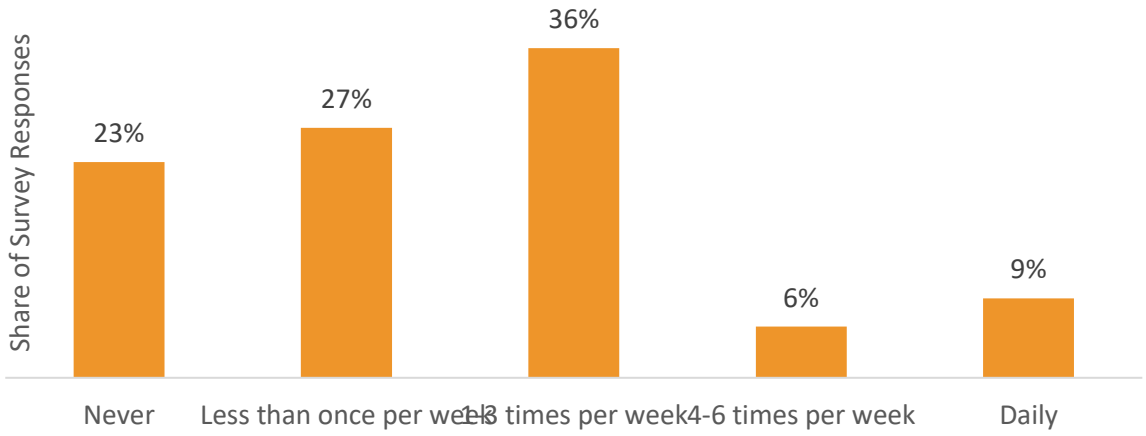
On average, the majority of drivers parking in Arizona gave up less than an hour of driving time to secure a parking space. When compared to ATRI's nationwide survey, Arizona's remaining drive times are lower than national times. However, these remaining drive times still represent a major cost for truck drivers parking in Arizona, particularly for the 38 percent of drivers giving up an hour or more.

63 percent of drivers give up 30 minutes or more of productive drive time to find parking each time they park in Arizona.

Rates of Parking in Undesignated Location

If a driver fails to find parking before they reach the end of their HOS, they may be forced to either park in an unauthorized or undesignated location, or violate HOS limits as they continue to drive in search of legal parking. Figure 2-10 shows the results of the survey question asking drivers how often they have to park in undesignated areas.

Figure 2-10: Undesignated Parking Frequency



Source: CPCS Survey.

Comparing the frequency a truck driver parked in Arizona to the frequency the driver said they had parked in an undesignated location revealed undesignated parking one to three times per week was among the most frequent response regardless of the frequency of parking in Arizona. This suggests that there will be an underlying frequency of parking in undesignated parking regardless of frequency or experience parking in Arizona.

2.5 Evaluation of Potential Solutions

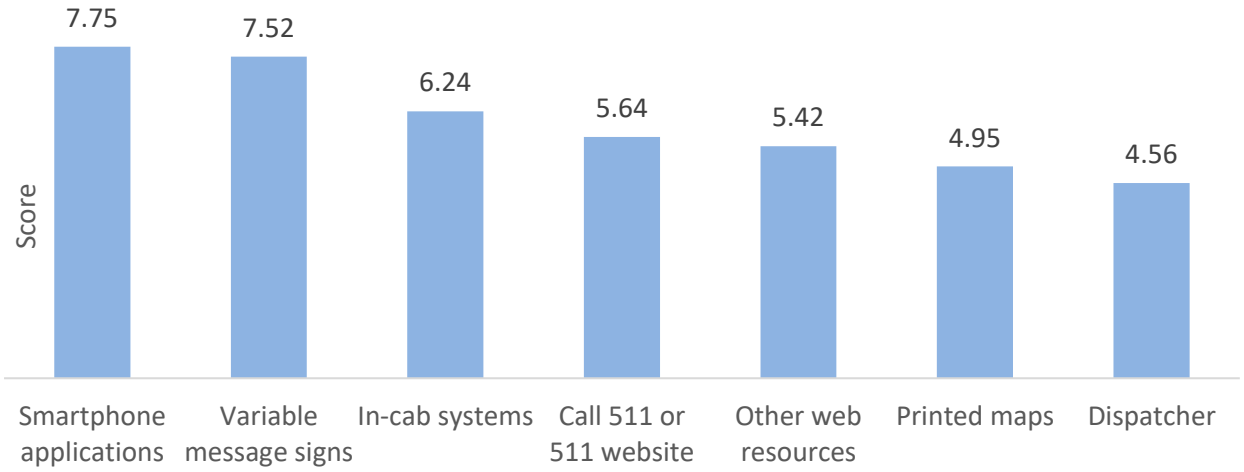
A comparison of the findings of this survey and national studies showed that drivers parking in Arizona spent more time searching for parking, but did not stop as early to secure a spot. If drivers had accurate information on parking availability, their search time could be reduced, and they may be able to drive longer. However, when asked to decide which factor was the primary cause of parking issues in the state, 78 percent of drivers said that a lack of parking spaces, not a lack of information.

78 percent of drivers attribute Arizona's truck parking problems to a lack of parking spaces rather than a lack of information.

Preferred Sources of Information

The survey of truck drivers also asked how drivers prefer to get information about parking locations and availability, respondents ranked seven information sources from best to worst. The top three sources were smartphone applications, variable message signs (VMS), and in-cab messaging systems. Figure 2-11 shows the relative ranks (higher the score the higher the rank) of each information source. The scoring of each source of truck parking information was calculated based on each respondent's rank, with nine being the highest score.

Figure 2-11: Truck driver's Preferred Parking Information Sources

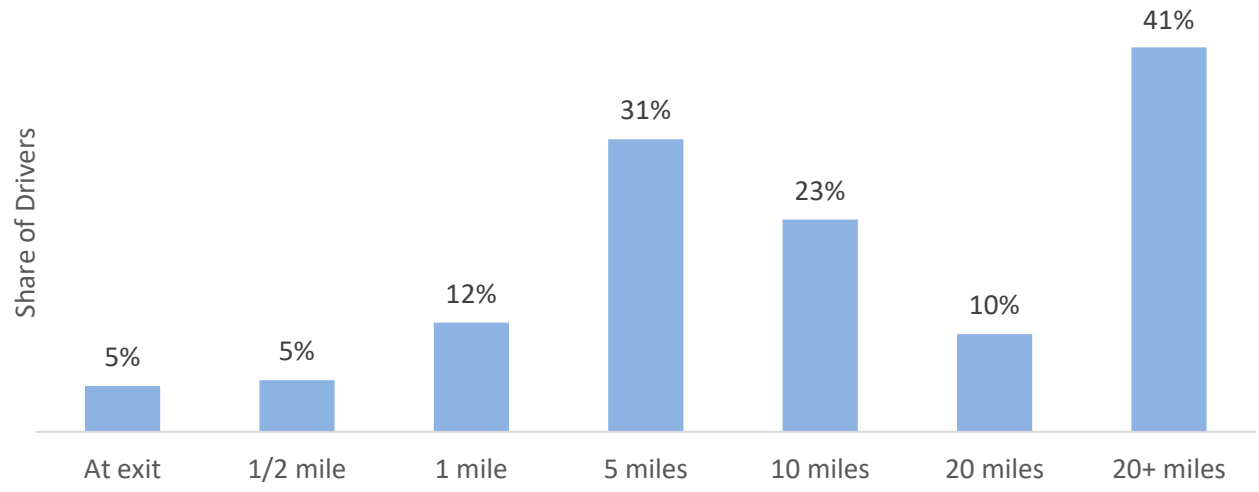


Source: CPCS Study.

Timing or Location of Information

Previous national studies also found that one of truck drivers' top preferences for information sources was VMS. Since VMS may be a possible parking information solution for Arizona, the research team asked truck drivers about when they wanted information about truck parking availability. The survey allowed truck drivers with the opportunity to select as many distances as they wanted. Figure 2-12 shows 5, 10, and 20+ miles were the top preferences among truck drivers.

Figure 2-12: Preferred Distances for Parking Information



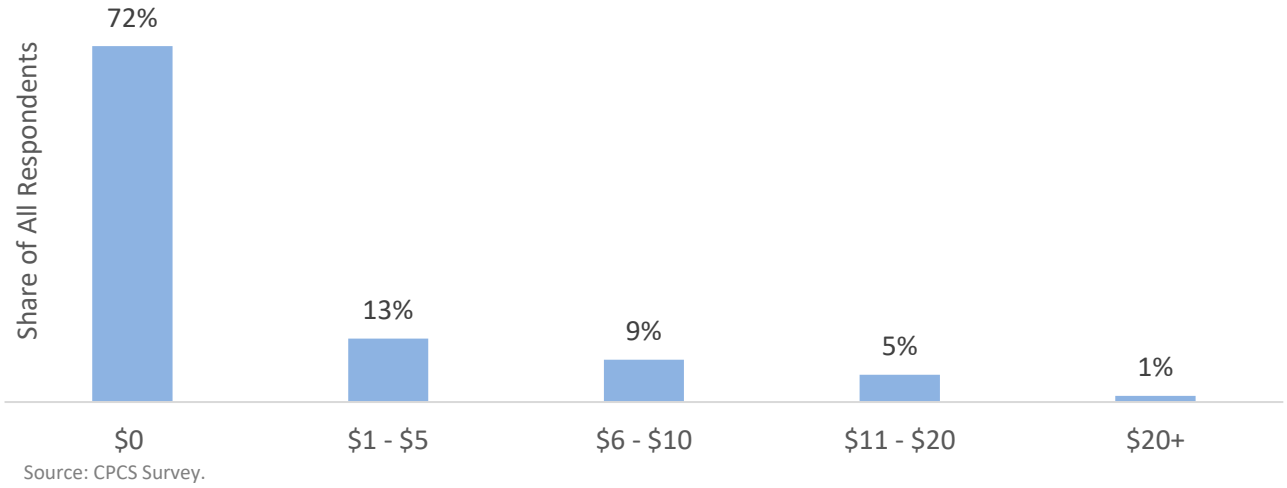
Source: CPCS Survey.

One member of the Truck Parking Advisory Group recommended that the research team should translate distance to time when applying the preferences shown in Figure 2-12. Travel time to truck parking accounts for different speeds depending on location, particularly in rural versus urban locations. Preferences for receiving parking information will serve as a basis for the studies recommendations and implementation.

Reservations for Parking Spaces

ATRI and others have studied industry acceptance of truck parking reservations as context for reservations providing a solution to truck parking issues. By reserving a parking space at a specific location, a truck driver could reduce their search time, improve utilization of their driving time, and avoid the anxiety of having to find a space. These reservation systems are already in place at some privately-owned truck stops in the United States. Previous research found that most truck drivers are unwilling to pay for parking reservations. As shown in Figure 2-13, the survey of truck drivers in Arizona is in line with previous studies, namely 72 percent of respondents were not willing to pay any amount for parking reservations. The remaining 28 percent of respondents were willing to pay from $1 to $20+, with the largest group (13 percent) willing to pay $1 to $5.

Figure 2-13: Willingness to pay for Parking Reservations



Source: CPCS Survey.

2.6 Conclusion

The results of the survey of truck drivers and industry consultations confirm that truck drivers encounter difficulty finding parking in Arizona. Because of this difficulty, truck drivers face the following consequences:

- **Spend time searching for parking**: 22 percent of drivers spent 16 to 30 minutes and 29 percent spent over 31 minutes searching for parking in Arizona.
- **Stop their workday early to find parking**: 63 percent of drivers give up more than 30 minutes to secure a parking space each time they park in Arizona.
- **Park in undesignated areas:** 50 percent of drivers park in an undesignated space such as a vacant lot, highway ramp, or local street in Arizona once a week or more.

Truck parking issues make trucking in Arizona less efficient, reduce highway safety, degrade infrastructure condition, and decrease the quality of life for truck drivers and local residents.

3 Truck Parking Demand Factors

Key Messages

Truck parking demand in Arizona is driven by many factors, including truck traffic volumes, the volume of imports and exports to and from the state, business practices like Just in Time inventory, and HOS regulations. In the near future, enforcement of the Electronic Logging Device mandate is likely to generate additional demand for truck parking in Arizona. On a longer timescale, the continued growth of the state's economy, particularly in retail and consumer goods trade, will increase parking demand.

3.1 Introduction

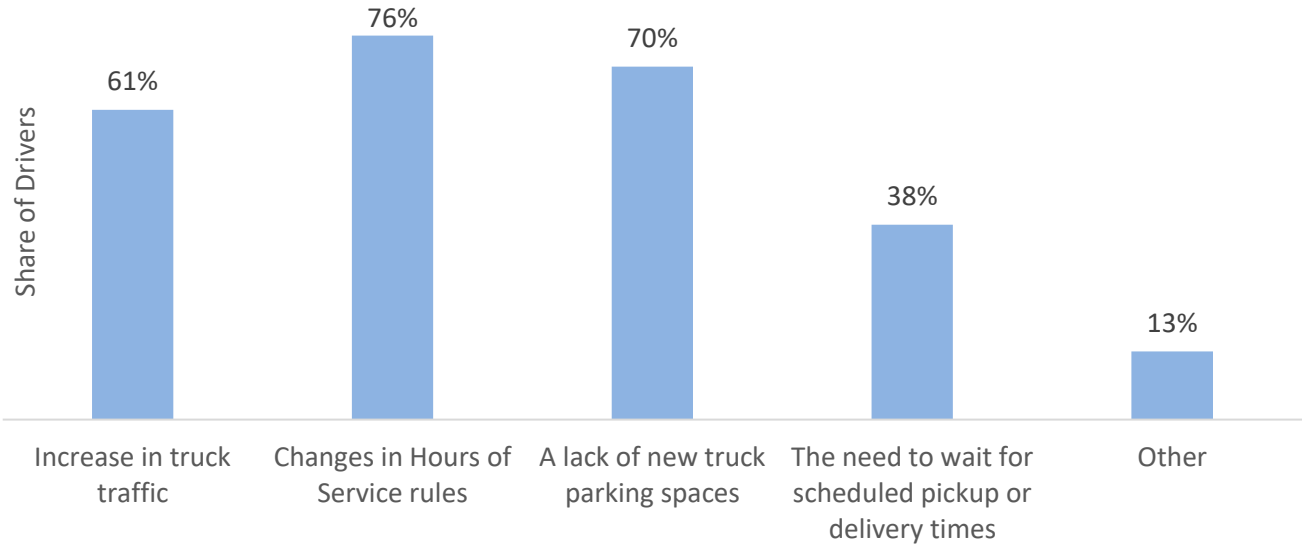
In order to understand the factors affecting truck parking in Arizona, this section explores the factors affecting truck parking demand. The analysis of demand factors will inform the development of solutions to truck parking issues. In addition to understanding the factors affecting demand now, it is also important to understand how demand for truck parking may change in the future. To develop this understanding, this chapter seeks to answer the following key questions:

- What demand factors, including freight activity, traffic volume, HOS regulations, and other issues affect truck parking demand statewide?
- What is the expected impact of the ELD mandate on truck parking in Arizona?
- What other factors are expected to affect truck parking availability in the future?

3.2 Factors Affecting Truck Parking in Arizona

When asked how the availability of truck parking has changed in the past three years, 72 percent of drivers surveyed said that truck parking problems in Arizona has gotten a little worse or much worse. When asked what is causing the change in truck parking availability, drivers most frequently selected changes in HOS rules (76 percent), a lack of new truck parking spaces (70 percent), an increase in truck traffic (61 percent), and waiting for scheduled pickup or delivery (38 percent). As shown in Figure 3-1, 13 percent of drivers selected "Other" and provided their own comments on the factors they thought were influencing changes in parking availability. Most driver responses related to the supply of truck parking, such as the closure of rest areas, or the increase in areas marked as "no parking." Demand-related responses mentioned concerns about the effects of the ELD mandate.

Figure 3-1: Factors Driving Changes in Parking Availability



Source: CPCS Survey.

The following sections will discuss how HOS, ELDs, an increase in truck traffic, and the need to stage for scheduled pickup and delivery times are contributing to Arizona's increased parking demand.

3.3 Hours of Service

The Federal Motor Carrier Safety Administration's (FMCSA) HOS regulations establish the legal limits for how long a driver can be on duty and drive each day. Each driver is limited to a total of 14 hours of "on duty" time each day. "On duty" is a blanket term that includes driving, as well as any other time spent on paid work for a carrier, such as loading, unloading, inspecting, fueling, or repairing. Within that 14 hour on duty window, HOS regulations limit a truck driver to driving for a maximum of 11 hours.

After 14 hours on duty or 11 hours of driving, whichever comes first, a driver is required to take a minimum 10 hour rest break before driving again. HOS regulations also govern shorter breaks. Truck drivers may not drive for more than eight hours without at least a 30 minute rest break. Finally, HOS rules also require drivers to take 34 hours off after driving more than 60 hours in seven days, or 70 hours in eight days.

HOS have broad effects on truck parking. The largest single impact is the requirement to stop for short and long breaks. The requirement to stop driving increases truck parking in cases where truck drivers would otherwise continue to

The History of Hours of Service

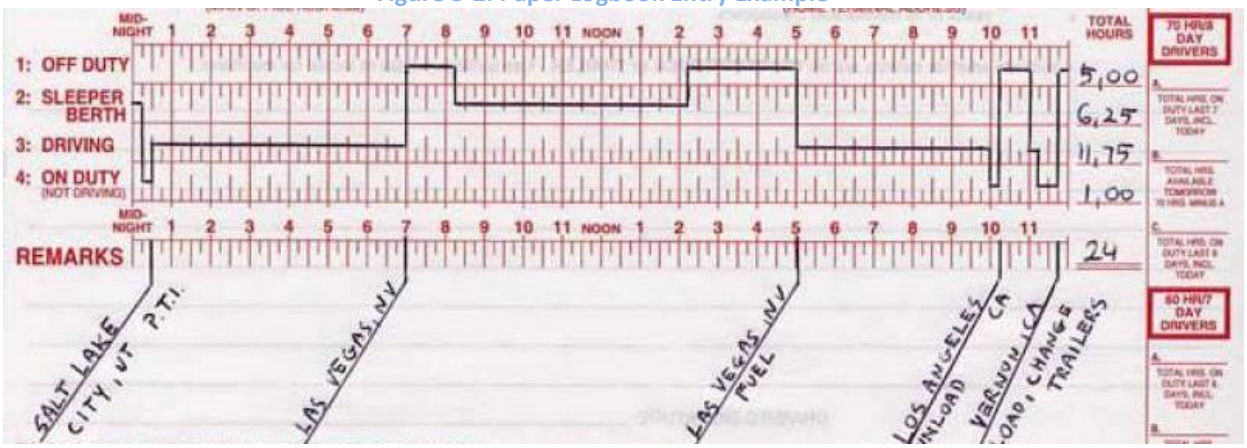
HOS regulations were first implemented in 1938 by the Interstate Commerce Commission. The first rules limited drivers to 12 hours of work (loading, unloading, driving, etc) within a 24 hour period. HOS regulations were heavily debated since their first introduction as evidenced by the change in rules in 1939 to limit driving to 10 hours. In addition to the change in 1939, HOS regulations have changed in 1962, 1963, 2003, 2011, and 2013.

drive until reaching a company truck yard or personal parking location. The impact of HOS on truck parking depends on how many truck drivers are willing to break the law, the penalty for violating HOS, and the likelihood of enforcement catching a driver traveling beyond their HOS. The recent ELD mandate, explained below, has changed the likelihood that a truck driver is caught for going over their HOS.

3.3.1 Hours of Service Enforcement and Violations

Historically, drivers were responsible for recording their HOS records in paper logbooks, which were subject to inspection by law enforcement. A sample paper logbook entry is shown in Figure 3-2.

Figure 3-2: Paper Logbook Entry Example



Source: North Bay Business Journal. 2017.

Violation of HOS regulations can result in a range of penalties including written warnings, fines, and putting a driver out of service. HOS enforcement is usually performed by state or local law enforcement, but violations are logged and tracked in the FMCSA's Safety Measurement System, which tracks safety risks such as unsafe driving citations, crash records, vehicle maintenance problems, hazardous materials compliance, and drug and alcohol violations. FMCSA addresses repeated violations with escalating warnings and penalties from Compliance Safety and Accountability program.

Figure 3-3 shows the top ten HOS violations in Arizona and their rank relative to all FMCSA violations. HOS violations and violations associated with HOS recordkeeping make up six of Arizona's top ten violations. The most common HOS violation is a general violation of recordkeeping rules, followed by a false record of duty status.

HOS related violations make up over 50 percent of Arizona's reported truck violations.

The violations listed in Figure 3-3 comprised 58 percent of Arizona's violations in FY 2017. For each type of violation, the number of violations is greater than the number of inspections. This

high rate of violations per inspection is due to law enforcement finding multiple violations during the inspection of a logbook.

Figure 3-3: HOS and Recordkeeping Violations in Arizona, FY2017

Rank	Violation	Inspections	Violations
1	General log violation	7,236	10,660
3	False report of record of duty status	3,388	4,066
4	Driving over 8 hours without a 30 minute break	2,213	3,103
5	Record of duty status not current	2,283	2,328
7	Driving beyond 14 hour duty period	1,337	1,533
9	Driver failure to retain previous 7 days of logs	1158	1182
11	No record of duty status	896	896
12	Driving beyond 11 hour limit in a 14 hour period	737	817
17	Driving beyond 14 hour duty period (nominal)	391	474
27	Driving beyond 11-hour limit in a 14 hour period (nominal)	205	230
All Violations and Inspections		66,146	43,335

Source: Federal Motor Carrier Management Information System, 2017.

These violations can result in a driver being taken out of service, an action that requires parking space. For example:

- 74 percent of drivers (3,004) cited for false record of duty service were taken out of service by law enforcement.
- 88 percent of drivers (1,036) cited for failing to keep their previous seven days of logs were taken out of service.
- 88 percent of drivers (787) cited for not keeping a record of duty status were taken out of service.

However, the demand for truck parking related to putting truck drivers out of service is focused largely at inspection locations and only impacts a small proportion of truck drivers. Whereas the general impact of HOS rules affect the majority of truck drivers

3.3.2 The Effect of Hours of Service Regulations on Truck Drivers' Decision Process

Truck drivers face uncertainty on two key variables when trying to find parking, travel time to the parking location and parking availability. Travel time is directly related to the amount of time the driver has left on their HOS, distance, and speed. HOS defines the number of hours that a driver has left to drive. Distance and the speed the driver can travel based on the law or the current operation of the infrastructure, define how far the driver can travel during their remaining driving time. Together the remaining drive time, distance, speed define whether or not a driver can make it to their desired truck parking location before they are in violation of HOS rules. Parking availability refers to whether there are parking spaces at the parking location when the truck driver arrives.

The focus on travel time reflects the desire of drivers to maximize the miles driven. If a driver stops early because they are unsure if they can reach a parking location within the HOS, they are giving up income (many drivers are paid by the mile), and they run the risk of not getting to the parking location within their HOS. For example, as a driver approaches 11th hour of driving

or the 14th hour on duty, they must consider the driving time they have left and the distance they can cover in that time.

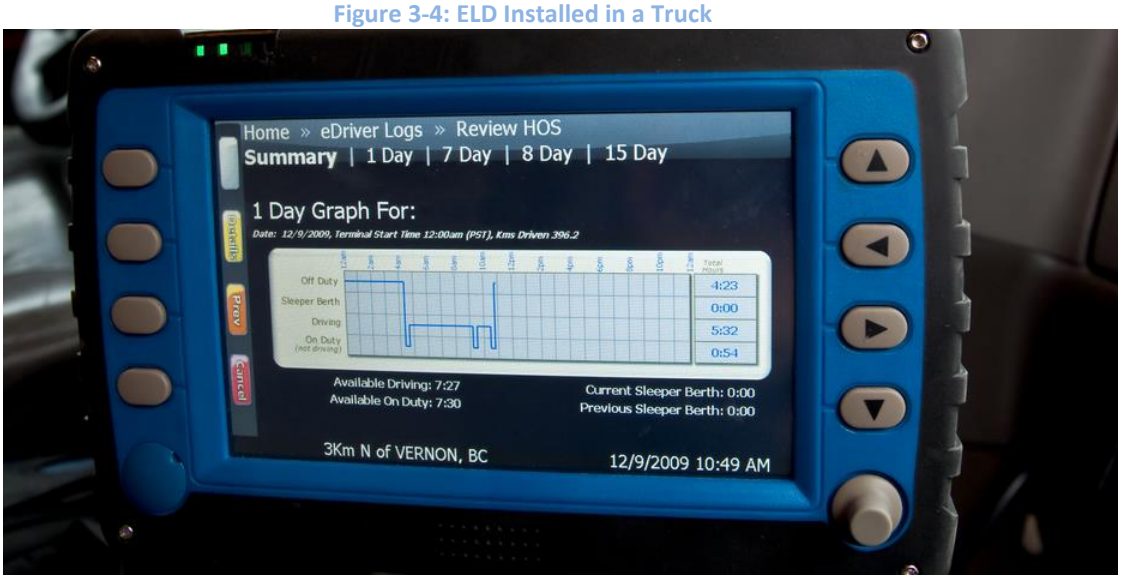
Even when a driver is confident they can reach a truck parking location within their HOS, they may be uncertain about the availability of parking spaces when they reach the location. If parking availability is uncertain and a driver wants to find a legal parking spot they have to spend driving time searching for parking and possibly stop driving earlier in the day to increase the certainty that they will find parking before their HOS expire. Both of these decisions reduce a drivers' productivity because they reduce the overall distance a driver can cover in a day. Alternately, drivers may "take a chance" and try to find parking when they reach the end of their HOS. If they fail to find legal parking they must either park in an undesignated or illegal location, or drive beyond their legal HOS.

HOS rules also influence how parking demand is distributed geographically. For example, parking demand may be concentrated on major corridors that are 10 to 11 hours away from large truck freight generators such as major ports or intermodal terminals. This is the case on I-10 around Tucson, where trucks originating at the Ports of LA and Long Beach and destined for locations east of Arizona reach the end of their available HOS.

3.4 The Electronic Logging Device Mandate and Parking Demand

ELDs are a replacement for the paper logbooks used to track a driver's HOS. These devices are intended to improve highway safety and reduce paperwork for truck drivers by automatically recording information about truck operations, and saving data in a tamper-proof system. Figure 3-4 shows an example of an ELD, which is visually similar to paper logs, but also automatically calculates and displays remaining drive and on duty time.

Figure 3-4: ELD Installed in a Truck

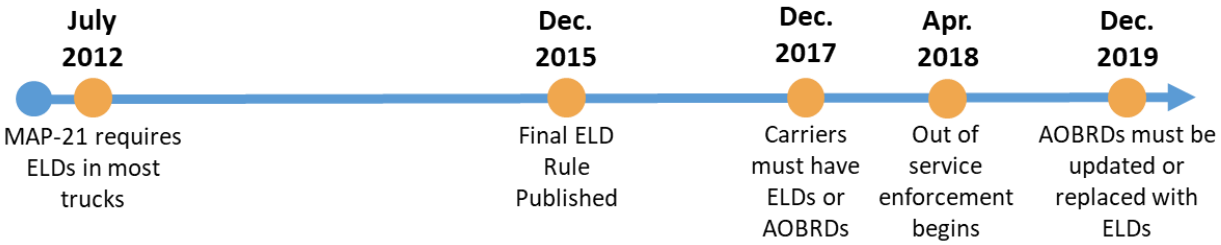


Source: Overdrive Online.

3.4.1 ELD History

In 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) mandated that use of ELDs for drivers who were previously required to keep records of their hours. Since the passage of MAP-21, the FMCSA has drafted and finalized rules governing the regulation, installation, and use of ELDs. A timeline of key events in the development of the ELD mandate is shown in Figure 3-5.

Figure 3-5: ELD Mandate Timeline



As of December 18th, most trucks must have either an ELD or Automatic Onboard Recording Device (AOBRD) installed. The Commercial Vehicle Safety Alliance, an association of state law enforcement agencies, announced that full enforcement of the ELD requirement will not begin until April 1st, 2018. After April 1st, vehicles without ELDs or AOBRDs will be placed out of service by law enforcement.[2] Finally, by December 16th, 2019, all AOBRDs must be upgraded to comply with ELD requirements or replaced with ELDs.

AOBRD vs ELD

AOBRDs were developed prior to the ELD rulemaking and have some limited functions relative to ELDs. For example, AOBRDs are not required to:

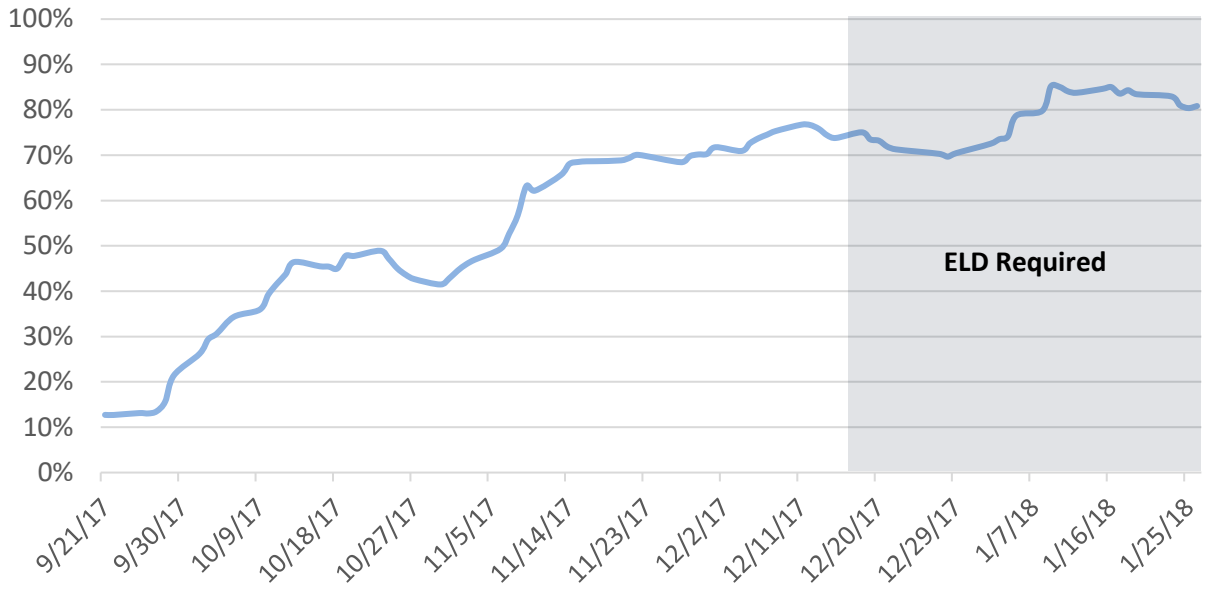
- Track a vehicle's location as frequently,
- Provide a graphic "grid" display of a drivers hours,
- Transmit data to law enforcement.

Source: AOBRDS vs ELDs: The Key Differences. Peoplenet.

Figure 3-6 displays the proportion of trucking firms in compliance with the ELD mandate based on a survey by CarrierLists. The survey covers over 5,200 trucking companies, ranging from companies with one truck to over 1,000 trucks. By the December 18th deadline, about 75 percent of trucking companies surveyed had implemented ELDs. Some trucking companies, such as firms transporting agricultural commodities, have received a short-term exemption from the ELD mandate. While some firms are able to drive without an ELD, others will be subject to fines if they are caught without an ELD.

[2] Cassidy, William. *ELD Enforcement to be 'Phased In' through April 2018.* August 28, 2017. Journal of Commerce.

Figure 3-6: Rates of ELD Compliance, Moving Average of the Previous Ten Days of Available Survey Data



Source: CPCS analysis of data from CarrierLists
Note: The rate of compliance is a moving average of the last ten days of data starting on September 8th, 2017 and ending January 26th, 2018.

3.4.2 ELD Operations and Possible Implications for Parking

An ELD interfaces directly with a truck's existing computers and diagnostic systems, and captures a range of data about the operations of a truck, including whether the engine is on, whether the truck is moving, mileage, and engine hours. ELDs are also required to automatically record a truck's location in multiple circumstances, including when a truck engine is turned on or off, when a driver comes on or off duty, and when the truck is moving.

Previously, paper logbooks gave drivers some "wiggle room" in reporting driving times, because paper logbooks monitored and documented driving time using 15 minute time blocks. This allowed truck drivers 15 minutes of flexible time to look for truck parking even after they had technically run out of 11 hours of drive-time (e.g. 11 hours ends at 7:00 p.m., but the log is good until 7:15 p.m.). However, the ELD mandate requires onboard computers to automatically record HOS changes to the minute, and thus have eliminated wiggle room that drivers could use to find parking.

ELDs also have greater limits on editing the log compared to paper logs. A driver could operate beyond their HOS limits to find parking or reach their destination, and adjust their logbooks to hide this overage time. However, ELDs automatically record when a truck is in motion and do not allow an edit to that record. Other changes in status, such as changing from off duty to on duty not driving, are allowed but ELDs do not allow drivers to erase data. The accurate recording, combined with tamper-proof requirements, has eliminated the flexibility of the paper logbooks.

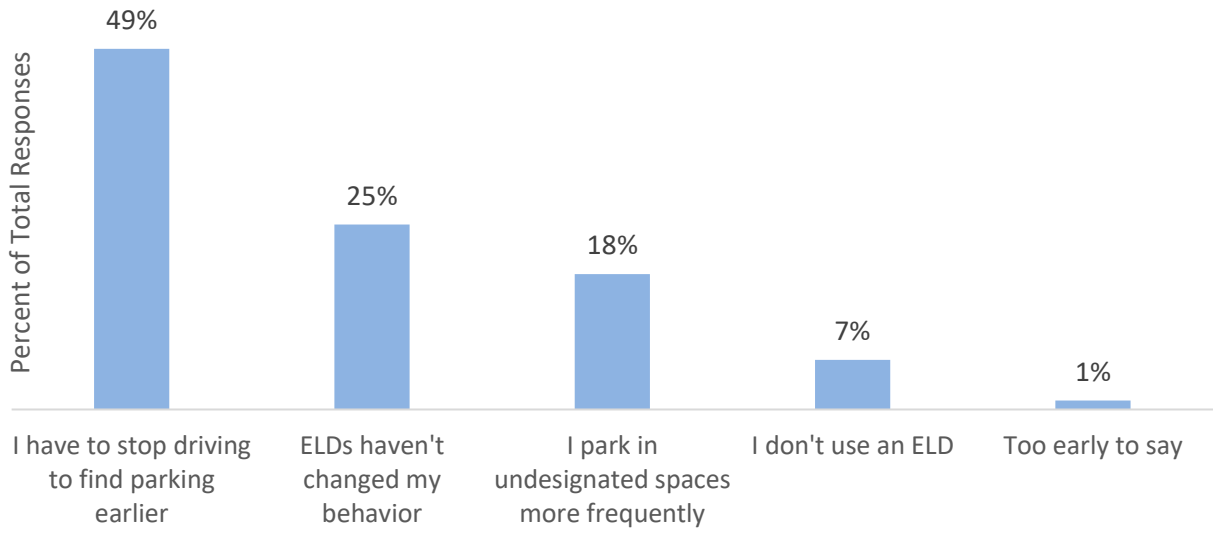
3.4.3 Survey Responses about ELDs

As part of our survey on truck parking issues in Arizona, truck drivers were asked about their perception of how ELD's would affect parking in the state. 93 percent of the drivers surveyed said they used an ELD, and 85 percent of the drivers believed that the ELD mandate would make parking problems in Arizona worse. Only 2 percent of drivers believed the mandate would improve truck parking in Arizona.

85 percent of truck drivers believe the ELD mandate will cause Arizona's truck parking problems to become worse.

The survey also asked drivers to describe how ELDs changed their parking behavior. The most frequent response (49 percent), said that ELDs forced drivers to stop driving to find parking earlier. Another 18 percent of drivers said they parked in undesignated spaces more frequently. 25 percent of respondents claimed that the installation of ELDs had not changed their parking behavior. Figure 3-7 shows the full range of responses.

Figure 3-7: ELDs' Impact on Parking Behavior



Source: CPCS Survey.

The 49 percent of drivers stopping earlier to find truck parking reflects that drivers no longer have the flexibility to find parking beyond the end of their HOS. Therefore, truck drivers must plan to stop driving earlier in order to minimize the chance they drive beyond their HOS or are forced to park in an undesignated location. This change in planning is complicated by the fact parking demand peaks in evenings and nights, when many drivers are taking their 10 hour rest breaks. This peak in demand often results in parking shortages, causing drivers who want to secure a spot in high demand locations to stop driving even earlier. In short, drivers believe that ELDs will have a negative impact on parking availability and will further reduce the distance freight can travel in a day, especially on corridors with parking shortages.

Truck drivers responded that ELDs effectively reduced the distance freight can travel in a day by causing drivers to stop earlier than they otherwise would.

ELDs will also increase the demand for truck parking due to drivers will no longer be able to reach their final destination, company terminal, or home by driving slightly beyond their HOS limits or altering their logbooks. As a result, these "stranded" drivers must find parking, even if they are a relatively short distance away from completing a trip. This "stranding" of drivers who previously could have completed their trip is expected to increase parking demand.

"As more drivers begin to run legal, this will be a tremendous burden on the available parking spaces because drivers that normally falsify their log to make it to their destination will be forced to stop and take their break on the road."
–Survey Respondent

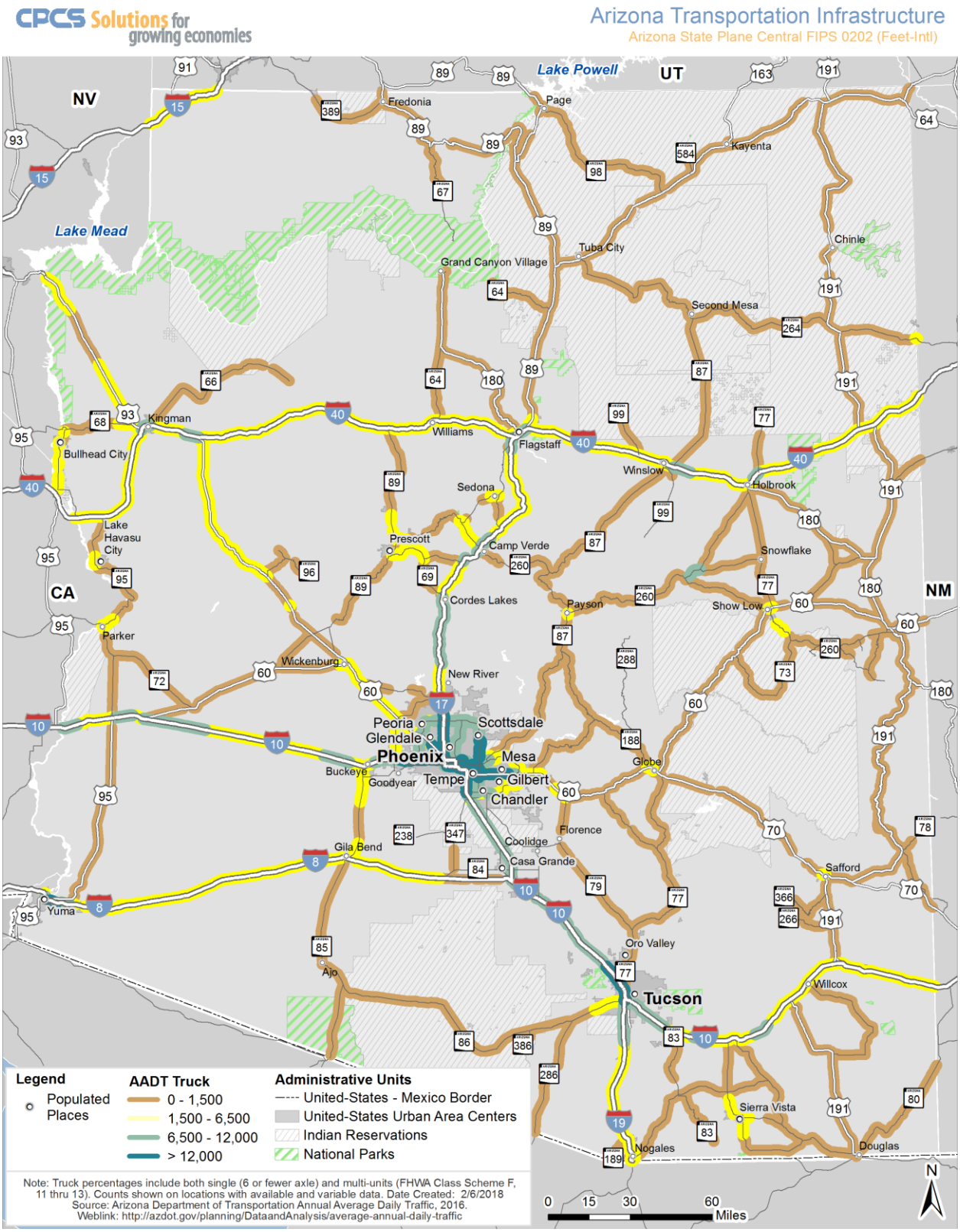
Industry Concerns about ELDs and Parking Demand

The industry executives consulted for this study did not believe that the ELD mandate would have an impact on their business practices and parking needs. Many larger carriers have already installed ELDs or AOBRDs, and their business practices and parking practices have already adjusted. One large carrier noted that parking problems had been more challenging in the early days of ELDs, but the company and its drivers had adapted to the new restrictions created by ELDs. Additionally, out of service enforcement of the ELD mandate will not begin until April 2018, and industry representatives felt the full effects of implementation may not be seen until April. Additionally, some major carriers provide dedicated truck parking at their terminals, and their drivers do not need to worry about general parking availability at rest areas or truck stops.

3.5 Economic Factors Driving Truck Parking Demand

The volume of trucks traveling on Arizona's major highways is one of the factors that most directly influence parking demand in both urban and rural areas of the state. Generally speaking, the more trucks on the road, the greater the demand for truck-related services, including parking. Figure 3-8 displays how this truck traffic is distributed across Arizona. Note that interstate highways, particularly in or around urban areas, such as Phoenix and Tucson, have the highest truck counts. Truck drivers frequently mentioned Phoenix and Tucson as problem areas for parking. Additionally, I-10, I-17, and I-19 connecting to these metropolitan areas, as well as I-40 in Flagstaff and Kingman have higher than average truck traffic.

Figure 3-8: Arizona Truck Volumes, 2016

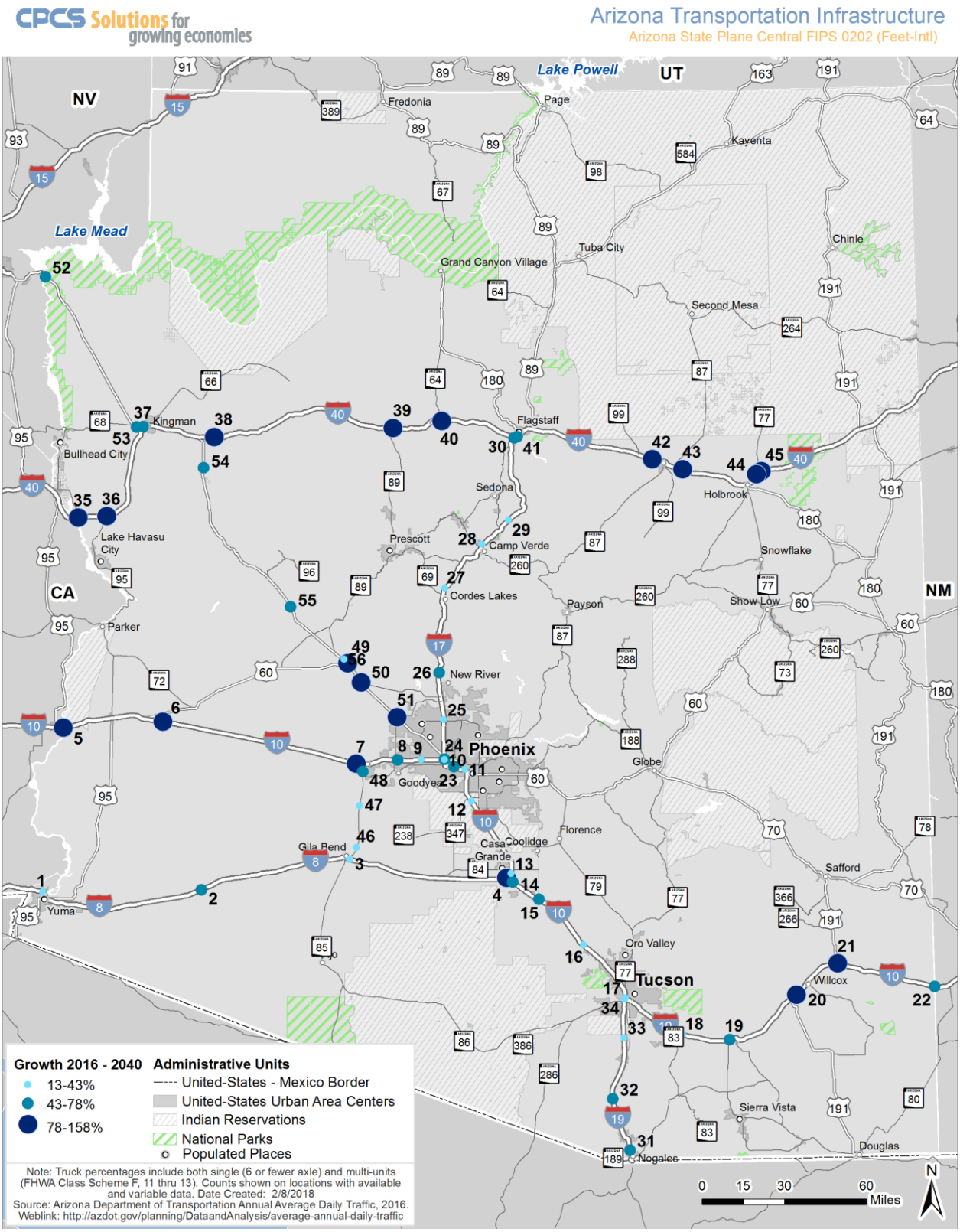


Source: HDR Analysis of Arizona DOT Average Annual Daily Traffic counts. 2016.

In order to forecast beyond current truck traffic, the research team used the Arizona Statewide Travel Demand Model (AZTDM) to develop projections and apply them to the 2016 traffic counts (by vehicle classification). Figure 3-9 displays the forecasted growth in truck vehicle miles traveled (VMT) from 2016 to 2040. US 60 near Phoenix and nearly all of I-40 are forecasted to have the largest growth of truck traffic on a percent basis. I-40 also comes to the top when measuring the growth of truck traffic by truck counts rather than on a percentage basis. In addition to I-40, I-10 from California to Phoenix also experiences significant growth on a percentage and truck count basis.

The data presented in Figure 3-8 and Figure 3-9 do not show if the trucks using these corridors require truck parking and where truck parking is needed by truck drivers. To address this gap, the research team will compare demand for truck parking developed in the next working paper with the analysis of current and future truck activity from this working paper. The comparison of truck parking use and truck activity will provide insight into the corridors that currently experience insufficient truck parking, as well as those that are likely to face issues in the future.

Figure 3-9: Percent Increase in Truck Traffic at Specific Locations in Arizona, 2016-2040



Source: HDR analysis of Arizona Statewide Travel Demand Model outputs.

3.5.1 Increasing Truck-Borne Trade with Other States

The volume of trade with other states is a factor affecting truck parking demand because these long-distance truck trips generate demand for long-term parking in both urban and rural areas. In addition to long-term parking, trucks coming from other states may need parking to stage for pick-up or delivery at freight facilities in Arizona. Truck drivers traveling through Arizona to other states, such as California or Texas, also generate truck parking demand. Through trips accounted for 61 percent of Arizona's truck tonnage, and 62 percent of its truck cargo value in 2013.[3]

Some demand for short-term staging parking is driven by the fact that truck drivers traveling long distances are subject to more variables when planning their parking locations. For example, a truck driver may encounter congestion or may have to wait longer than planned to be loaded or unloaded. As such, truck drivers have to build in this uncertainty in their trip planning to ensure they meet the delivery requirements of the load they are carrying. Accounting for uncertainty means drivers may arrive before their scheduled pickup or delivery time and require a place to park. Arizona's online survey responses reflect truck drivers need to find parking in order to stage for a pick-up or delivery, finding 73 percent of national drivers and 72 percent of southwestern drivers said they used truck parking to wait for scheduled pickup or delivery times.

Figure 3-10 illustrates how truck tonnage is expected to nearly double between 2013 and 2040. This expected increase in inbound and outbound truck tonnage means that demand for parking in Arizona will likely continue to increase.

Figure 3-10: Arizona's Forecasted Truck Tonnage Increase Between 2013 and 2040

Category	Outbound from AZ	Inbound to AZ	AZ to AZ	Through AZ	Total
Tonnage	89%	114%	75%	119%	99%
Value	247%	200%	130%	149%	161%

Source: HDR analysis of Transearch data, received in November 2015,

3.5.2 Growth of Warehousing and Distribution

The inbound and outbound shipments described above often originate or terminate at warehouses and distribution centers. These facilities rely heavily on truck service, and have grown rapidly in the past 15 years. Between 2000 and 2014, firms spent nearly $2 billion to construct 35 million square feet of warehouse and distribution space in Arizona.[4]

35 million square feet of warehouse and distribution space was built in Arizona between 2000 and 2014.

[3] HDR Analysis of IHS Transearch data. 2013.
[4] Arizona State Freight Plan Working Paper: Transportation and Logistics.

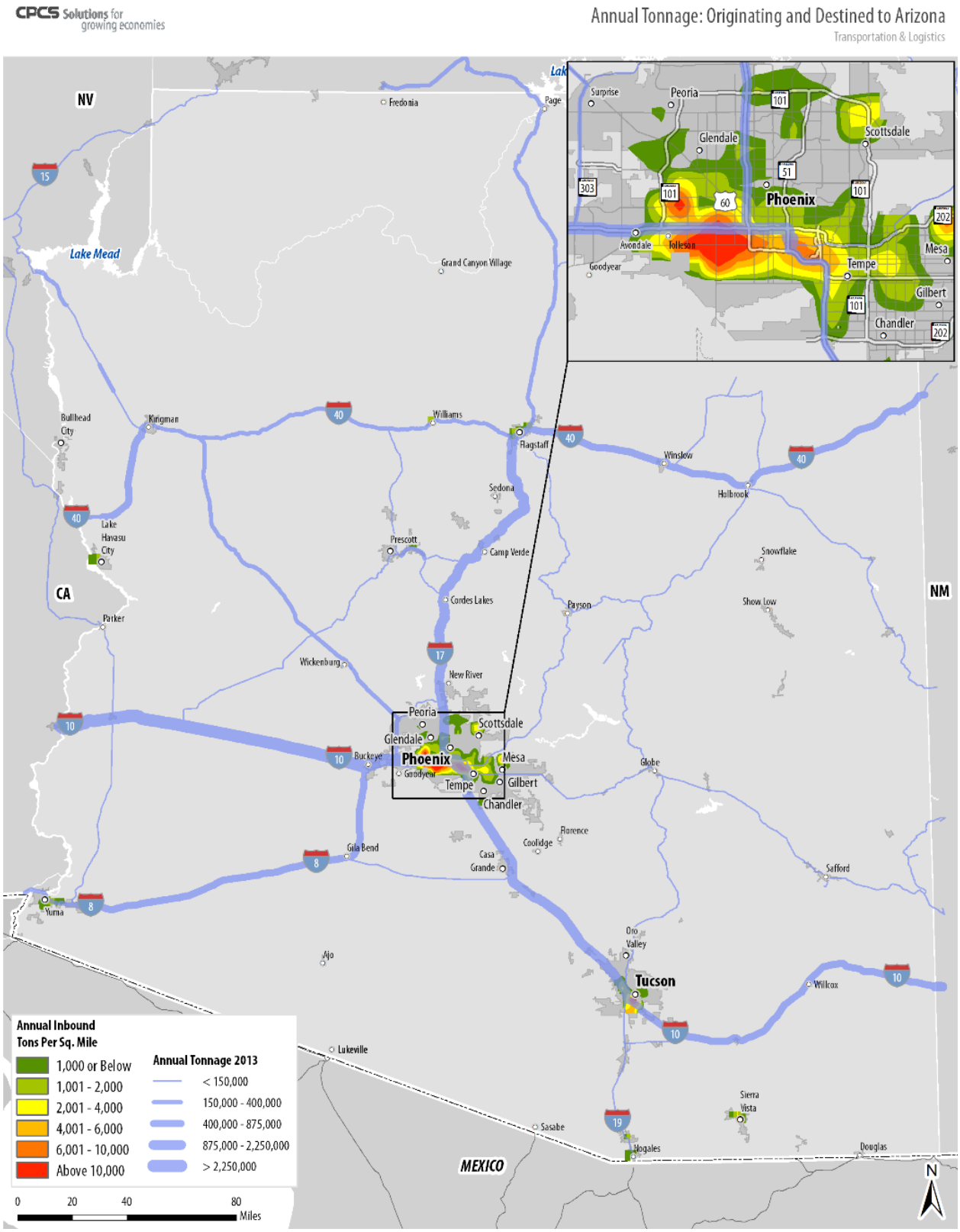
Trucking is the primary mode of transportation for freight associated with warehouses and distribution centers. As a result, these facilities generate large amounts of truck traffic, and demand for parking, but frequently have prohibitions or insufficient parking on-site. A common complaint from truck drivers in the online survey was a lack of parking at or near warehouses or distribution centers.

The demand for parking that is created by these facilities is not uniform. Since trucks need to stage for access at specific times, parking demand for truck activity related to warehouses and distribution centers is highest close to clusters of these businesses. Figure 3-11 shows how these facilities are clustered in Arizona's cities, especially Phoenix and Tucson. These cities were also the most-mentioned areas for parking problems in the online survey of truck drivers.

New warehouses and distribution centers will exacerbate the lack of truck parking in urban areas if new capacity is not added at or near these facilities.

Looking toward the future, parking for staging at warehouses and distribution centers will continue to be a problem in urban areas for two reasons. First, continued development of warehouses and distribution centers will continue to create new demand. Second, as congestion increases in urban areas, travel times will become less certain. Therefore, drivers who have fixed appointment windows will need to get closer to their final destination when searching for parking. Drivers staging for pick-ups or deliveries may be able to use the decrease in mid-day parking demand to easily find parking, but drivers searching for parking during peak overnight periods will encounter difficulty.

Figure 3-11: Transportation and Logistics Freight Clusters



Retail and Wholesale Sector

The development of new warehouses and distribution centers is being driven in large part by the growth and changing business practices of Arizona's consumer retail and wholesale sector. This sector is made up of firms that facilitate the distribution of finished goods to businesses and consumers. These firms include grocery stores, general retail stores, and e-commerce firms such as Amazon.

Freight and Trucking Relevant of the Wholesale and Retail Sector

- Generates 28 million tons of freight in Arizona, 20 percent of the state's total freight tonnage
- 95 percent of Retail and Wholesale freight is moved by trucks
- 60 percent of inbound retail and wholesale freight originates in California
- Adoption of Just-In-Time inventories is driving additional truck traffic – and additional parking demand.

Since retail and wholesale firms drive much of the development of Arizona's distribution centers and warehouses, trends in the growth of retail and wholesale firms could indicate future increases in the demand for the types of parking associated with distribution centers and warehouses. As of 2015, the retail and wholesale sector generated 28 million tons of freight in Arizona, about 20 percent of the state's total freight tonnage. About 60 percent of Arizona's inbound retail and wholesale freight originates in California, particularly at the ports of Los Angeles and Long Beach.[5] Drivers carrying freight to Arizona from the port will likely reach their HOS limits shortly before, or immediately after arriving in Arizona's urban areas.

Just-In-Time Supply Chains

Arizona's retail and wholesale firms generate a large amount of freight simply by virtue of their large size. However, these firms, and other types of firms such as manufacturers are generating additional truck traffic and parking demand because of their adoption of Just-In-Time (JIT) supply chain logistics. JIT is a strategy that minimizes inventory by receiving goods as they are needed, which reduces the costs associated with holding inventory. The adoption of JIT systems has necessitated the growth of centralized warehouses and distribution centers described above. It has also necessitated the generation of additional truck trips, since smaller amounts of freight are needed on shorter notice more frequently. In fact, some companies have adopted a "rolling inventory" model, where the majority of their limited inventory stock is whatever freight is currently in transit from a warehouse or distribution center to a store or factory.

The higher truck volume required to support JIT inventory, coupled with limited loading zones at warehouses and distribution centers means that these facilities have adopted scheduled pickup and delivery times discussed elsewhere in this working paper. These facilities rarely allow parking onsite, so truck drivers waiting for scheduled times must find parking elsewhere, adding to parking demand.

[5] Arizona State Freight Plan Working Paper: Transportation and Logistics.

3.6 Technology

Advances in technology, specifically connected vehicles (CV) and autonomous vehicles (AV) have the potential to affect the demand for truck parking in Arizona and nationwide. The impacts of CVs and AVs is speculative due to unknowns about the speed of technological advancement, rate of industry adoption, and government regulation. The following section outlines the potential impacts of CVs and AVs on truck parking.

3.6.1 Connected Vehicles

CV technology could affect truck parking through both the provision of information using Vehicle-to-Infrastructure (V2I) communication and through changes in HOS when using platooning. V2I is the transmission of data between vehicles and the infrastructure, with data streams potentially moving in both directions. For example, V2I could enable vehicles traveling on a roadway to transmit speed data or if the vehicle was involved in an accident to the infrastructure, informing decisions of infrastructure operators. V2I could also enable the transmission of information from the infrastructure to other vehicles traveling on the roadway. For example, V2I could be used to notify other roadway users that poor performance or an accident is ahead. The transmission of data from the infrastructure to vehicles has the potential to minimize the chance of further accidents and help divert vehicles around an area with poor performance.

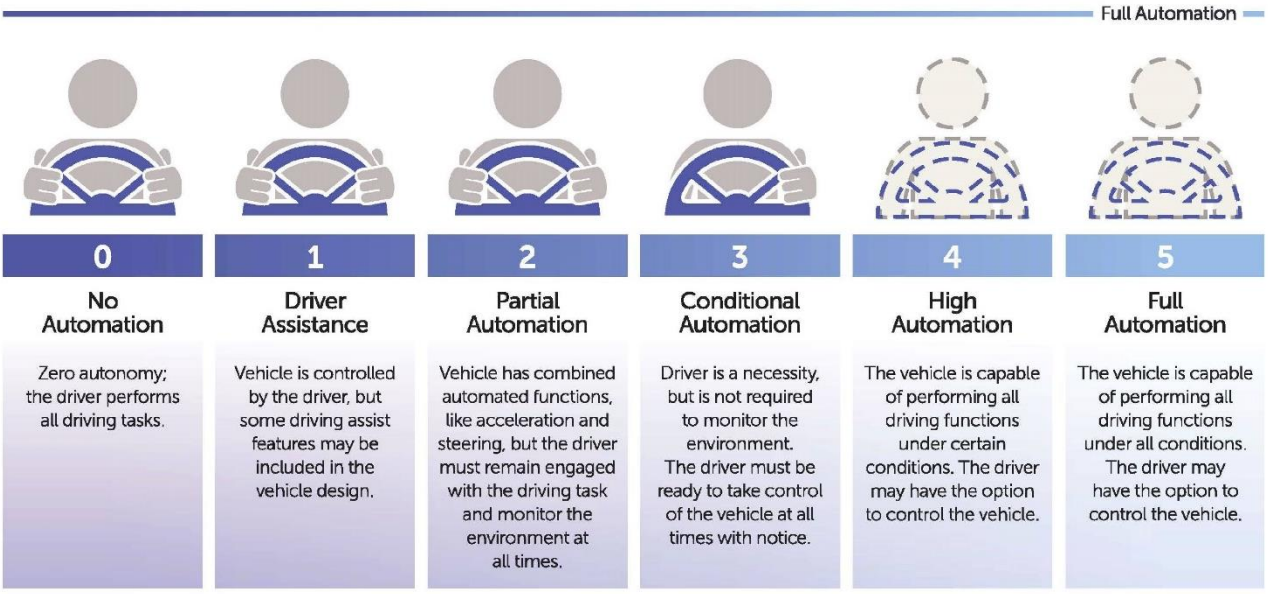
V2I is relevant for truck parking because it has the potential to supplement or replace VMS as a means to communicate the availability of truck parking. Additionally, trucks could transmit their use of truck parking spaces to the infrastructure and serve as a means to collect information on truck parking availability. The promise of V2I is contingent on instrumenting trucks, other roadway users, and infrastructure with the technology needed to collect, use, and transmit information.

Platooning or vehicle-to-vehicle communication is the transmission of information between vehicles. For example, Peloton sells sensors and supporting software that allows two equipped vehicles to travel as a platoon. When traveling as a platoon, the lead truck controls the speed and braking of the truck at the rear of the platoon. The connection between the two trucks allows for a reduced following distance, which increases fuel economy of both vehicles. Platooning could reduce the demand for truck parking if future iterations of platooning removes the requirement for a driver in the rear truck or allows the driver in the rear truck to rest while platooning. Advances in platooning technology and changes to state and federal regulations will be required before platooning reduces the demand for truck parking.

3.6.2 Autonomous Vehicles

AVs involve different levels of control, with some functions handled by the driver and others by the vehicle. The National Highway Traffic Safety Administration (NHTSA) and the Society of Automotive Engineers have defined AV levels as shown in Figure 3-12.[6]

Figure 3-12: Autonomous Vehicle Scale



Source: NHTSA, *Automated Driving Systems 2.0: A Vision for Safety.*

Large trucks are generally classified as Level 0, with adaptive cruise control or braking moving the truck into Level 1. Low levels of automation do not have an impact on truck parking demand, but, higher levels of the AV scale could change truck parking demand if changes to HOS regulations are made. For example, Level 4 technologies could allow a driver to rest while the vehicle is on specific roadways. If drivers can take their rest while the truck is in control, they will not require truck parking to comply with HOS as frequently. A Level 5 AV could operate without a driver and would remove the need for HOS regulations and HOS-associated parking.[7]

Level 4 and 5 AVs have the potential to change truck parking demand, but would require HOS guidance or legislation specifying how HOS apply to AVs. Additionally, Level 4 and 5 AVs could change the way truck parking is used, depending on what roadways allow AVs. For example, AVs could use existing truck parking exclusively for staging or as a location where AVs wait for a driver to take the truck to the loading or unloading point.

3.7 Conclusion

Truck parking demand is a function of many interrelated economic and regulatory factors, including truck traffic volumes, the volume of imports and exports to and from the state,

[6] National Highway Traffic Safety Administration, 2017. *Automated Driving Systems 2.0: A Vision for Safety*.
[7] Short, Jeff and Dan Murray. *Identifying Autonomous Vehicle Technology Impacts on the Trucking Industry*. American Transportation Research Institute. Arlington, VA. November 2016.

business practices like JIT inventory, warehousing and distribution center growth, congestion, HOS regulations and the ELD mandate. Together these factors define the demand for truck parking.

Looking toward the future, demand for truck parking will likely increase in the future, exacerbating existing parking shortages. Future working papers will focus on developing a better understanding of how parking demand varies across the state, and what role and solutions ADOT can use to address a shortage in truck parking.

4 Next Steps

Key Messages

The research team will use demand factors established here and data from third party sources to measure parking supply of and demand for truck parking in Arizona.

4.1 Next Steps

The next step of this research project will be to assess current parking demand. This assessment of will include an evaluation of utilization of existing facilities, and will answer the following key question and sub-questions.

- Where are trucks currently parking in Arizona and are they parking legally or illegally (e.g. rest area on-ramp and off-ramp shoulder parking)?
- What is the current capacity of truck parking in Arizona?
- What are the gaps between current truck parking supply and demand of safe and legal truck parking spaces?
- Where are the gaps most acute, by corridor and general location?
- For legal parking, what is the magnitude of overcrowding at public truck parking locations, including rest areas.