Appendix D - Transit Market and Origin-Destination Analysis September 2018

CAMBRIDGE SYSTEMATICS

Long Range Regional Transit Plan

Market and Origin-Destination Analysis

prepared for

Pima Association of Governments

prepared by

Cambridge Systematics, Inc.

September 7, 2018

www.camsys.com

report

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date

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Executive Summary

This market analysis has two goals: identify target markets to sustain and grow the competitive position for transit in the Tucson region and specify travel markets where transit is not and may not become a competitive market without significant changes to the built environment or socioeconomic characteristics. These goals ensure the most effective investments in infrastructure and service. Data-driven market analysis seeks understanding of traveler's trip making patterns and the attitudes and preferences that drive their mode choices. This understanding can be gained from existing surveys and travel demand models or can involve collecting new data from traveler's GPS devices and surveys of traveler's attitudes and preferences.

This market analysis applies available data from the Pima Association of Governments (PAG) Travel Demand Model, which provides current and future demographics, travel behavior, roadway and transit networks, traffic conditions, and land use. These data are sufficient to provide a reasonable understanding of the current and likely future demand for transit based on the assumptions and future growth scenario PAG has adopted for its regional plan, the 2045 Regional Mobility and Accessibility Plan (RMAP).

To analyze travel demand, this report examines :

- Travel patterns: the origin, destination, and route (when possible) and trip characteristics such as time of day (peak or off-peak), trip purpose, and mode of travel.
- Traveler characteristics: the household socioeconomic characteristics (age, income, car ownership, gender, etc.) and residential and work land use characteristics (distance, density, a mix of uses, parking supply and cost, et.).

The analysis of this information provides the context to better understand where transit may or may not compete effectively with single-occupancy vehicles. It may also help determine where less competitive markets for transit may be improved through the integration of first/last-mile connectivity services, parking policies, transit priority treatments, land use policies, pedestrian and bicycle infrastructure and investments, travel demand management (TDM) programs, and other amenities and strategies.

Key Findings

The key findings of the analysis are organized into three critical market drivers of transit ridership: household characteristics, travel patterns, and the built environment.

Household Characteristics

To understand travel demand from the perspective of households of existing and potential transit passengers, this analysis examines the patterns of household characteristics most associated with the likelihood to choose transit. These factors include: include low-income households, younger adults, older school-age children, and households with low vehicle ownership.

Comparisons between Tucson UZA residents and existing transit passengers living in low-income households highlighted the importance of **maintaining a strong network of transportation choices to help maintain affordable transportation costs** for households within the Tucson region (Section 2.2). The importance of affordability is emphasized when comparing the median household incomes in the state of

Arizona and the Tucson Urbanized Area (UZA). Within the Tucson UZA, median household income is $6,000 lower than the state's average and the median household income of existing transit passengers is less than half of the state's average.[1]

The Tucson region is also aging (Section 2.4). While the Tucson UZA captures a greater share of those under the age of 35 years old when compared to Pima County, the **share of residents older than 65 increased from 13 percent in 2005 to 17 percent in 2016.[2] Nonetheless, only five percent of existing transit passengers are above the age of 65.[3]** It is also important to note that three out of every ten householders above the age of 65 years have an income of less than $25,000. This market segment merits exploration into transportation and built environment solutions for aging populations like coordinated public, nonprofit, and private transportation services, collocating senior housing near fixed-route transit, and continued infrastructure improvements like sidewalks, crosswalks, and curb ramps.

Low vehicle ownership (Section 2.6) is also a key driver of transit usage in the Tucson region. **One in every ten people within the Tucson UZA live in a household that does not have access to a vehicle**.[4] Half of all existing transit passengers live in households with no access to a vehicle. **Of the passengers who do not have access to a personal vehicle, 20 percent state that if Sun Tran was not available, they would not make the trip**.[5] Transit plays a critical function for the mobility of Tucson residents today and will continue as the region continues its steady growth.

Travel Patterns

Analysis of travel behavior including a comparison of travel time by mode and trip flow patterns illustrates the travel demand and needs of existing and potential transit passengers. Comparing transit and automobile trip patterns provides insights into the opportunities for transit to better compete with single-occupancy automobile travel. Currently, **transit represents only 1.5 percent of all trips** in the region, although it reaches **above ten percent in the neighborhoods within the downtown area including Armory Park, Barrio Anita, Barrio Viejo, El Presidio, and Downtown** (Section 3.1).[6] Transit commute trips represent a significant portion of transit ridership, representing one out of every four trips.

The analysis reveals several key opportunities for transit to adapt to the current travel market. One significant opportunity is to develop strategies to capture more short trips or trips between one and five miles in length. **Currently, transit trips represent only 1.6 percent of that short-distance travel market, which itself represents 46 percent of all travel within the region.**[6] The majority of these short trips within the region originates in the subregions of Campus Farm, University, Palo Verde, Northeast, South Park and, as shown in Figure ES.1. The short-distance travel between these subregions represents one out of every five trips made in the Tucson region.

[1] U.S. Census, 2016 American Community Survey 5-Year Estimates, Sun Tran On-Board Transit Survey, June 2016

[2] IPUMS-USA. Steven Ruggles, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek. IPUMS USA: Version 8.0 [dataset]. Minneapolis, MN: IPUMS, 2018. https://doi.org/10.18128/D010.V8.0

[3] Sun Tran On-Board Transit Survey, June 2016.

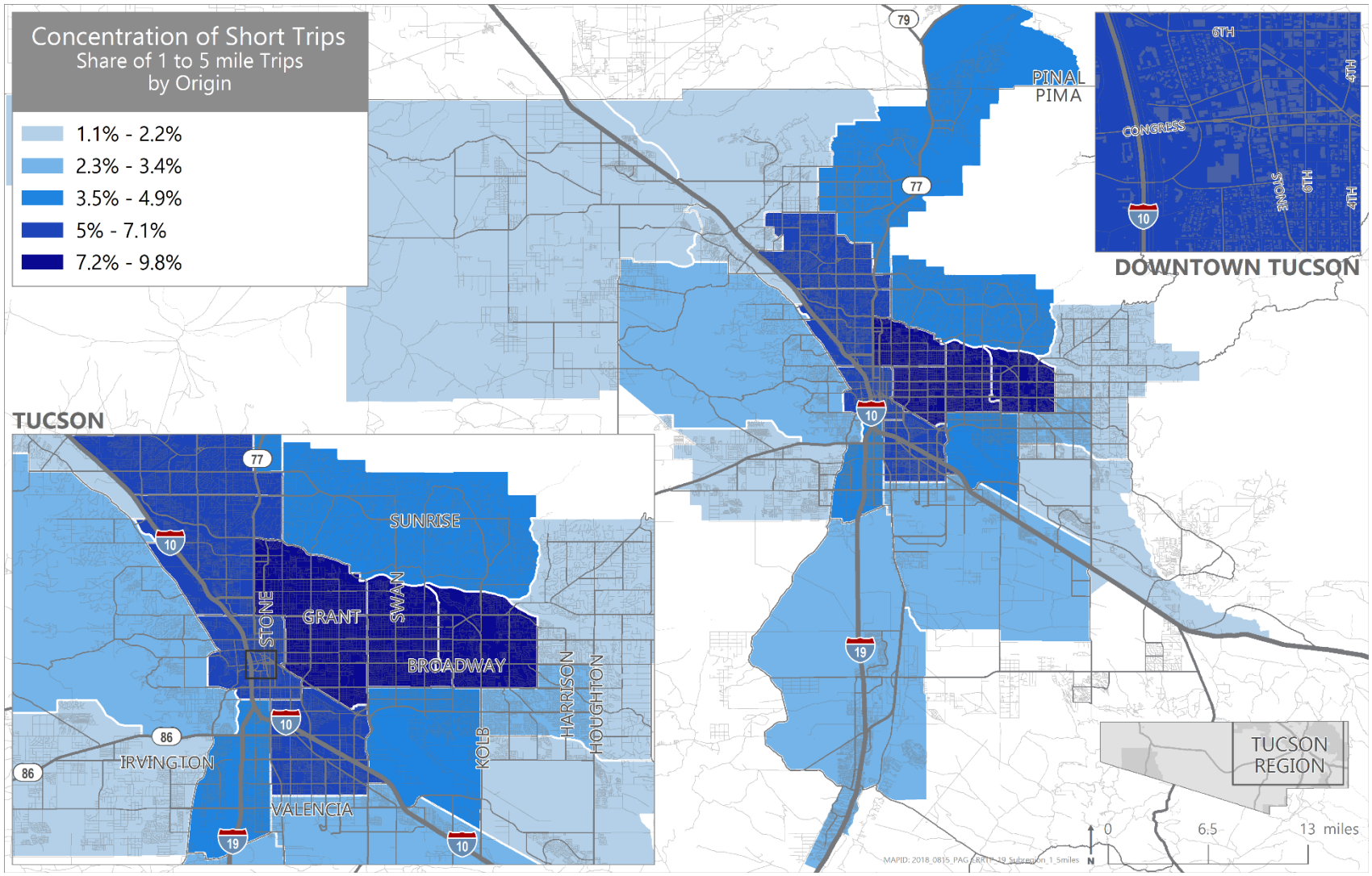
[4] 2016 American Community Survey, 5-Year Estimate

[5] Sun Tran On-Board Transit Survey, 2016

[6] Pima Association of Governments Travel Demand Model Data, 2017

Another key opportunity for transit to capture a greater share of trips is a reduction in per-trip travel time, especially compared to automobile travel (Section 3.2). To understand time competitiveness, the market analysis compared automobile trips and transit trips to two major regional destinations, downtown Tucson and the University of Arizona. **The majority of transit trips to either destination take over twice as long as the comparable automobile trip. Wait and walk time contribute a significant amount of the total transit travel time.** Of those transit trips that are one to five miles in length, wait and walk time take an average of 70 percent of the total trip time, 24 percent is spent waiting and 46 percent is spent walking.[6] For an example, consider a resident living in Enchanted Hills traveling about four miles to downtown Tucson for work. To reach downtown by transit, the resident will need to reach the neighborhood bus stop that is a half-mile away, involving an eight-minute walk. The average wait time for the bus to arrive is 15 minutes (assumed at half the headway frequency). Once the passenger has boarded the bus, the passenger will ride for 26 minutes to the bus stop downtown. The passenger will then walk several blocks, about five minutes to reach the final destination. As a result, walking and waiting are the majority of the trip.

Figure ES.1 Concentration of Short Trips



Source: Pima Association of Governments Travel Demand Model Data, 2017.

Built Environment

Understanding the existing built environment of the region, the land use currently served by transit, the trends of employment, the basic urban form, and focus areas for future development provides a perspective on the attractions that contribute to potential transit demand. Transit-supportive land uses, such as multi-family residential and the concentration of jobs, influence travel behavior and play an important role in encouraging, and discouraging transit ridership (Section 4.0).

Much of the region's growth is occurring in areas near existing transit service, or areas which could feasibly be served by new transit service. The compact and linear street grid patterns of Tucson support the medium- to high-density multi-family residential and commercial land uses along major corridors near downtown and the University of Arizona. The concentration of housing and businesses provides a number of destinations attractive to transit passengers. While the growing demand near Tucson's core and transit corridors indicates an opportunity for a gain in transit ridership, the **significant land area (almost 60 percent, especially prominent in the outlying communities) dedicated to single-family residential uses generates barriers for competitive transit service** (Section 4.2).[7]

The Tucson region has experienced the benefits of coordinated land use and transportation planning with the recent Sun Link streetcar investment and coordinated development investment (Section 4.7). Leveraging the value of the public investment to increase the concentration of housing, jobs, shopping and other amenities in key transit corridors connected by walkable streets will help the region maintain a sustainable transit network that maximizes return on public investment.

Key Market Conditions

This market analysis provides information about household characteristics, travel patterns and the built environment that will influence potential transit market. We will provide this data for application to the development of service concepts, which will be developed in a subsequent phase of this study. A summary of key market conditions includes the following:

- Aging residents in north and east Tucson;
- Millennial populations in downtown Tucson, northwest Tucson, and surrounding the University of Arizona;
- Households with no or low access to vehicles in the neighborhoods around downtown, northwest Tucson, near the University of Arizona, and east Tucson;
- Short distance (1-5 miles) noncommute travel between the University of Arizona and surrounding neighborhoods; and
- Both peak and off-peak commute trips connecting major employers to nearby neighborhoods between downtown Tucson and east Tucson, between the University of Arizona and northeast Tucson, and between the University of Arizona and northwest Tucson.

[7] Based on existing zoning classifications, Pima Association of Governments

1.0 Introduction

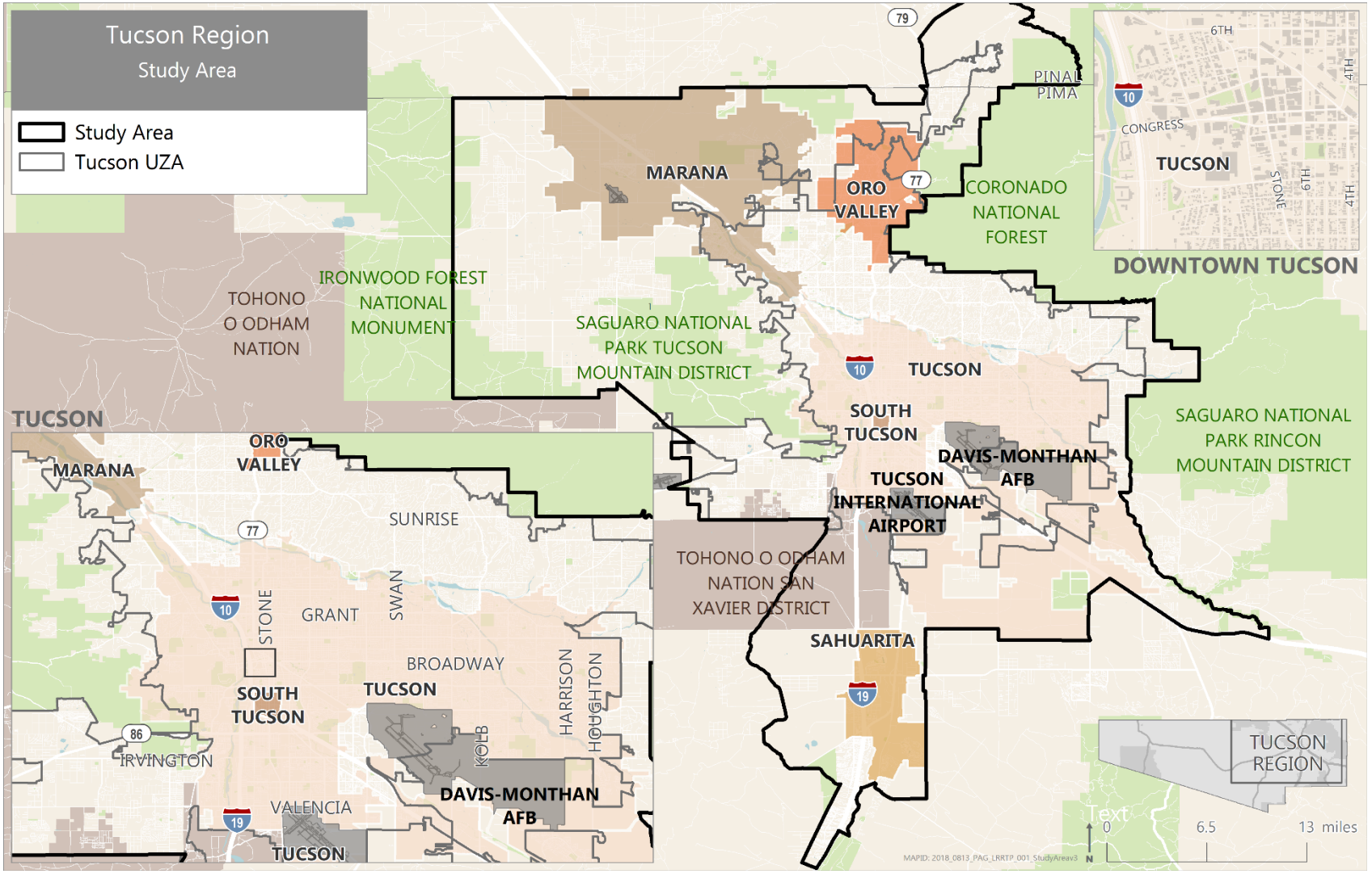
The Tucson region and its cities, towns, and rural form a complex, diverse, and dynamic transportation marketplace. Tucson serves as a major destination located along I-10, which connects Tucson to Los Angeles, Phoenix, El Paso, and the Southern United States; I-19 connects Tucson to the border city of Nogales in Sonora. The region is also connected by Amtrak passenger rail service on the Sunset Limited (between Los Angeles and New Orleans) and the Texas Eagle (between Los Angeles and Chicago).

Two interstates, I-10 and I-19 provide critical connections in a region where geographic growth is restrained by its natural features of the Coronado National Forest, the Saguaro National Park, Ironwood Forest National Monument, Tucson Mountain Park, the tribal lands of Tohono O'odham Nation Reservation and Pascua Yaqui Nation, and the incorporated cities of Marana, Oro Valley and Sahuarita, at the region's peripheries, as shown in Figure 1.1.

Decades of investment in infrastructure and services in the Tucson region have reinforced its prominence as the economic center of southeastern Arizona and helped continue growth in the region. The transit system serving the greater Tucson region includes fixed-route bus (Sun Tran), streetcar (Sun Link), express (Sun Express), shuttle (Sun Shuttle), share ride (Sun RideShare), and paratransit services (Sun Van). Sun Tran operates regular fixed route services in Tucson, South Tucson, the Tohono O'odham Nation, Pasqua Yaqui Tribe, and unincorporated Pima County. Sun Link streetcar service connects Mercado San Agustin, downtown Tucson, 4th Avenue, Main Gate Square and the University of Arizona. Sun Express provides limited-stop, peak-hour commute service from the outlying areas to major destinations, like the University of Arizona, downtown Tucson, and the Aero Park Complex. Sun Shuttle, funded by the Regional Transportation Authority, provides local and regional fixed-route services in outlying areas connecting to Sun Tran services. Sun Shuttle also provides Sun Shuttle "Dial-a-Ride" services providing door-to-door paratransit services. Sun RideShare is a regional commuter assistance program to encourage residents to travel by carpooling, vanpooling and other transportation alternatives. Sun Van provides paratransit services to eligible residents.

One of the region's most significant drivers of transit ridership comes from the University of Arizona, which has a total enrollment of over 44,800, of which about 42,000 are undergraduates. The campus of covers over 660 acres inside the city. About 20 percent of the students live in the 23 dorms on campus, while the remaining and 80 percent of students live off campus. All students receive a 50 percent discount for all transit passes: e.g., the $608 2018-19 Annual Express U-Pass costs students $304. On-campus annual parking costs range from more than $1,800 for a reserved space, to $900 for a garage space, to $100 for park-n-ride. Transit trips to the University of Arizona account for about ten percent of all transit trips. Of those transit trips destined for the University of Arizona, the majority of passengers access the service by walking and about eight percent access the service by park-n-ride. The average trip distance to the University of Arizona from or to home is 3.5 miles.

Figure 1.1 Tucson Region and Study Area



Recently, new transportation services like Uber, Lyft, and Tugo Bikeshare have emerged that may complement or compete with traditional, fixed-route transit service to serve the mobility needs of Pima County's residents, workers, students, and visitors. As the region develops existing service and introduces new and emerging transportation technologies, it is important to understand the travel market in terms of transit competitiveness.

Nationwide, transit ridership has declined over the past five years. Fixed-route bus ridership has decreased by 8.4 percent; only a few transit modes (including bus rapid transit, light rail transit, and demand response) have increased slightly.[8] However, several agencies have been able to increase ridership by investing in transit service, improving reliability across the transit network, and by aligning the network to better match transit demand.

This market analysis identifies opportunities to increase the competitiveness of transit by adapting service to complement changing demographics, travel behavior and land use across the region. Understanding these various markets will help determine the appropriate transportation investments to ensure useful, equitable, and efficient transportation choices across the region.

To analyze travel demand, this report examines :

- Travel patterns: the origin, destination, and route (when possible) and trip characteristics such as time of day (peak or off-peak), trip purpose, and mode of travel.
- Traveler characteristics: the household socioeconomic characteristics (age, income, car ownership, gender, etc.) and residential and work land use characteristics (distance, density, a mix of uses, parking supply and cost, et.).

The analysis of this information provides decision-makers with context to identify areas where transit can or cannot compete effectively with single-occupancy vehicles.

[8] USDOT, Federal Transit Administration (2017, October). 2016 National Transit Summary and Trends. Retrieved August 8, 2018, from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ntd/66011/2016-ntst.pdf

2.0 Household Characteristics

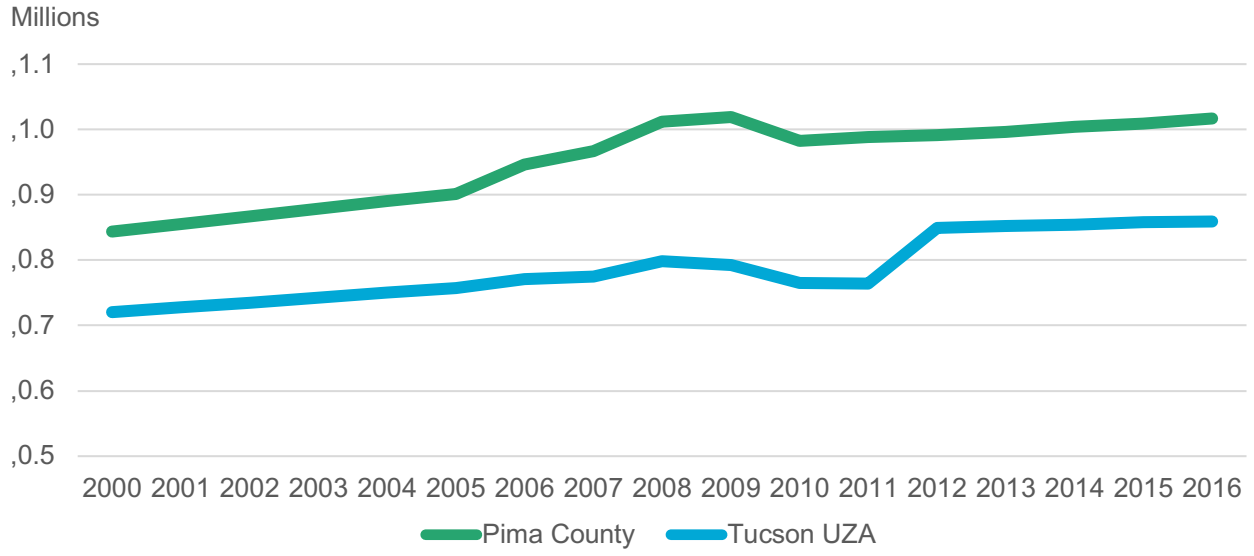
Understanding the travel market requires an awareness of residents and the neighborhoods in which they live. Socioeconomic factors can help predict travel behavior and identify trends that may affect future transit ridership.

Socioeconomic characteristics most correlated with transit propensity include households with low vehicle ownership, low-income households, younger adults, and older school-age children. This section provides an overview of the current demographics and trends and focuses on determining the potential drivers of frequent transit use specific to the Tucson Urbanized Area (UZA) and Pima County.

2.1 Population Density

In 2016, the Tucson Metropolitan Statistical Area (composed solely of Pima County) was home to one million residents, making it the second largest metropolitan area in Arizona and the 53rd largest in the United States. The region has been growing steadily, adding nearly 175,000 new residents since 2000 (an average annual growth rate of 1.2 percent), with the majority of new residents settling in the Tucson UZA (Figure 2.1). However, the growth has slowed in recent years, with nearly 34,000 new residents since 2010 and an average annual growth rate of 0.57 percent. Regional growth since 2010 is lower than the United States' average annual population growth rate of 0.73 percent. Approximately 85 percent of residents within Pima County live in the Tucson UZA, a share which has historically been consistent due to the expanding UZA boundary.

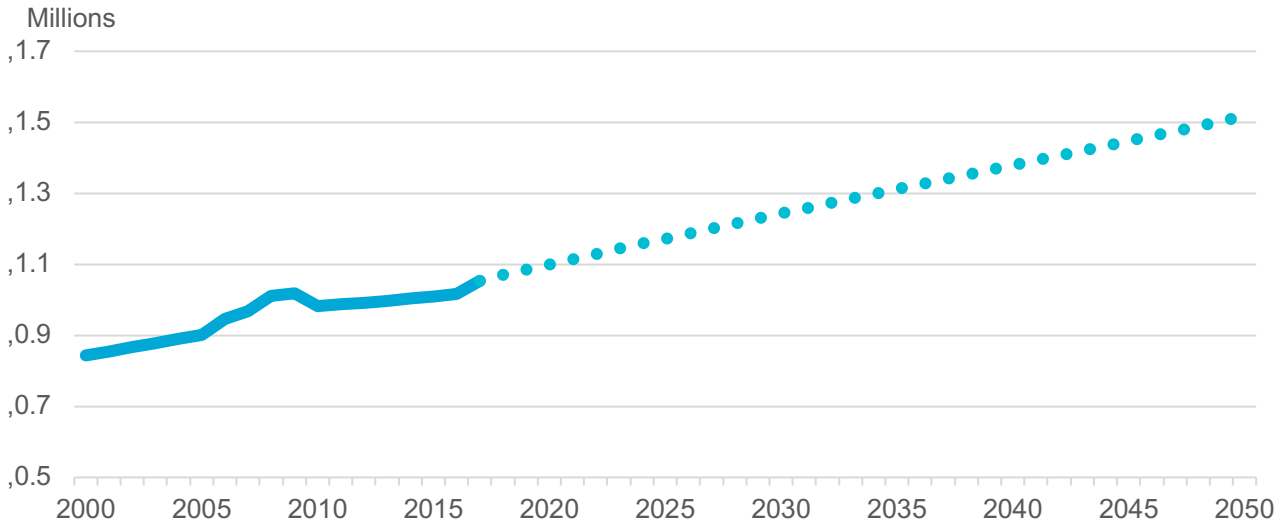
Figure 2.1 Population Share of Pima County and Tucson UZA



Source: U.S. Census, American Community Survey, and IPUMS-USA

Pima County is expected to continue growing by an estimated additional 465,000 residents between 2017 and 2050, an average annual increase of 1.1 percent which is a similar growth rate between 2000 and 2016, as shown in Figure 2.2. Increased local services, housing, and new development will be needed to accommodate this growth.

Figure 2.2 Pima County Population Projection



Source: Pima Association of Governments, *2013-2050 Incorporated Places Population Projects in Pima* County; U.S. Census, American Community Survey; and IPUMS-USA

2.2 Household Income

In 2016, the median household income in the Tucson UZA, as shown in Figure 2.3, was $44,900. This is nearly $10,000 lower than that of the United States and lower than the median in both Arizona and Pima County. **According to results from the 2016 Sun Tran On-Board Transit Passenger Survey, existing transit passengers[9] have a median household income of around $20,000; 93 percent of respondents have a household income of less than $50,000.**

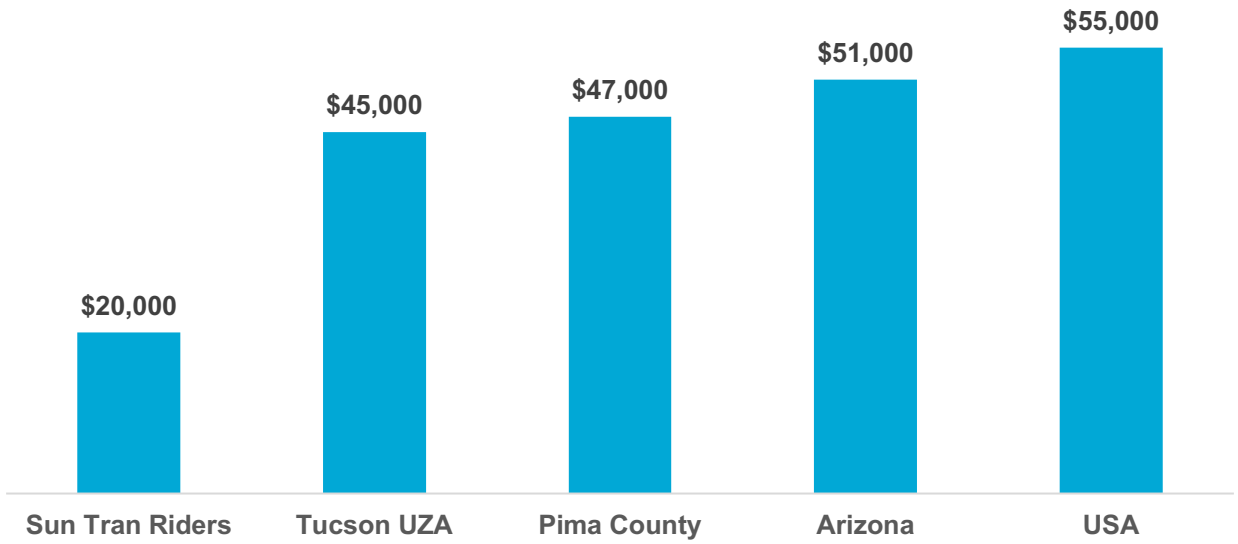
Low household income has a direct impact on the number of trips a household takes and how those trips are taken, whether driven alone or taken by transit. Traditionally, as household income increases, the number of trips taken increases and the likelihood of these trips taken alone in a vehicle increases. Conversely, the National Household Travel Survey (NHTS) data shows a higher portion of trips made by low-income households are by transit, bicycle, and walking when compared to all households.[10] This can be attributed to the costs of owning and operating a vehicle, such as gasoline, maintenance, insurance and parking.[11]

[9] Defined as passengers of Sun Tran, Sun Link and Sun Shuttle as surveyed by the Sun Tran On-Board Transit Passenger Survey.

[10] https://www.fhwa.dot.gov/policy/otps/travel_behavior_research_scan.pdf

[11] https://nhts.ornl.gov/briefs/PovertyBrief.pdf

Figure 2.3 Median Household Income in 2016 (2016$)



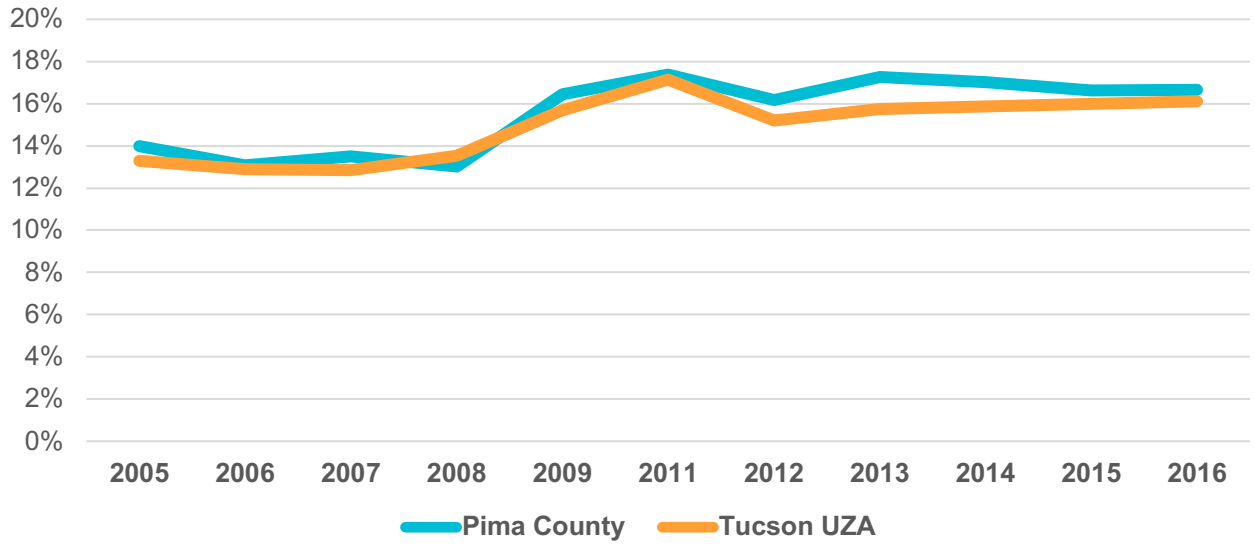
Source: U.S. Census, 2016 American Community Survey 5-Year Estimates, Sun Tran On-Board Transit Passenger Survey, June 2016.

In 2016, approximately 16.1 percent of households in the Tucson UZA were below the Federal poverty level.[12] A similar proportion of households in Pima County were below the poverty level, at 16.7 percent. Pima County and the Tucson UZA have a similar percentage of households below the poverty level, with the highest share in 2011 and lowest in 2008 shown in Figure 2.4. Since the Great Recession, the poverty level has remained fairly consistent, with the share of Tucson UZA households below the Federal poverty level less than the county. Similar to income, households below the poverty level have unique travel behavior. These households have the lowest rates of single occupancy vehicle use, have lower vehicle ownership rates, and are more likely to use modes like transit, carpooling, bicycling or walking.[13]

[12] The Federal poverty level is defined as households earning less than $11,880 to $40,890, depending on family size. The $11,880 threshold is for a family of one while the $40,890 threshold is for a family of eight. https://aspe.hhs.gov/computations-2016-poverty-guidelines

[13] https://nhts.ornl.gov/briefs/PovertyBrief.pdf

Figure 2.4 Percent of Households Below Poverty Level

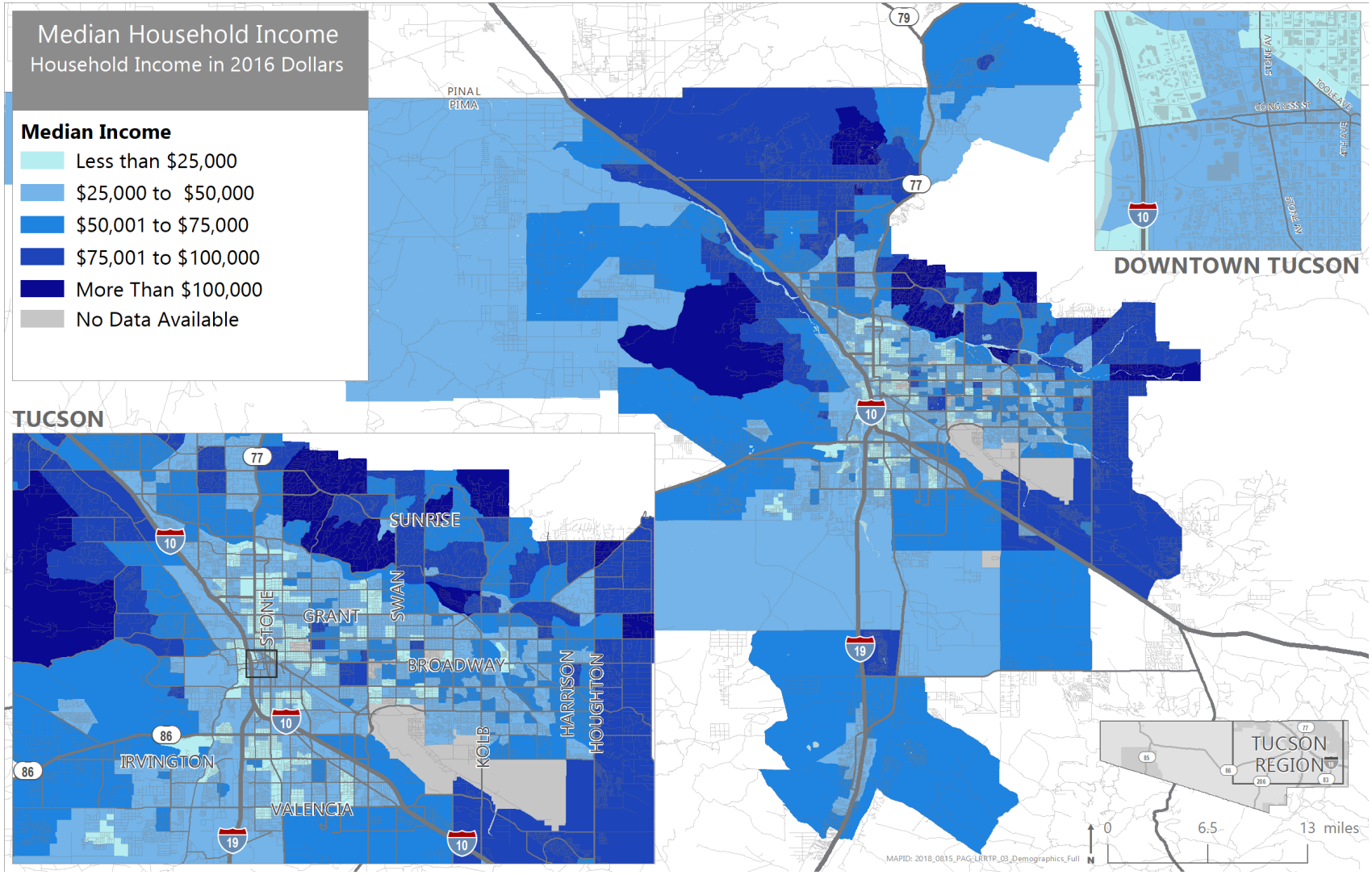


Source: U.S. Census, 2016 American Community Survey and IPUMS-USA

Maintaining viable transportation choices within the Tucson region, particularly around downtown, will decrease transportation costs for households and help with the regional goals of reducing vehicle miles traveled.[14] The differences between median household income by neighborhood are depicted in Figure 2.5

[14] https://www.tucsonaz.gov/files/integrated-planning/Plan_Tucson_Complete_Doc_11-13-13.pdf

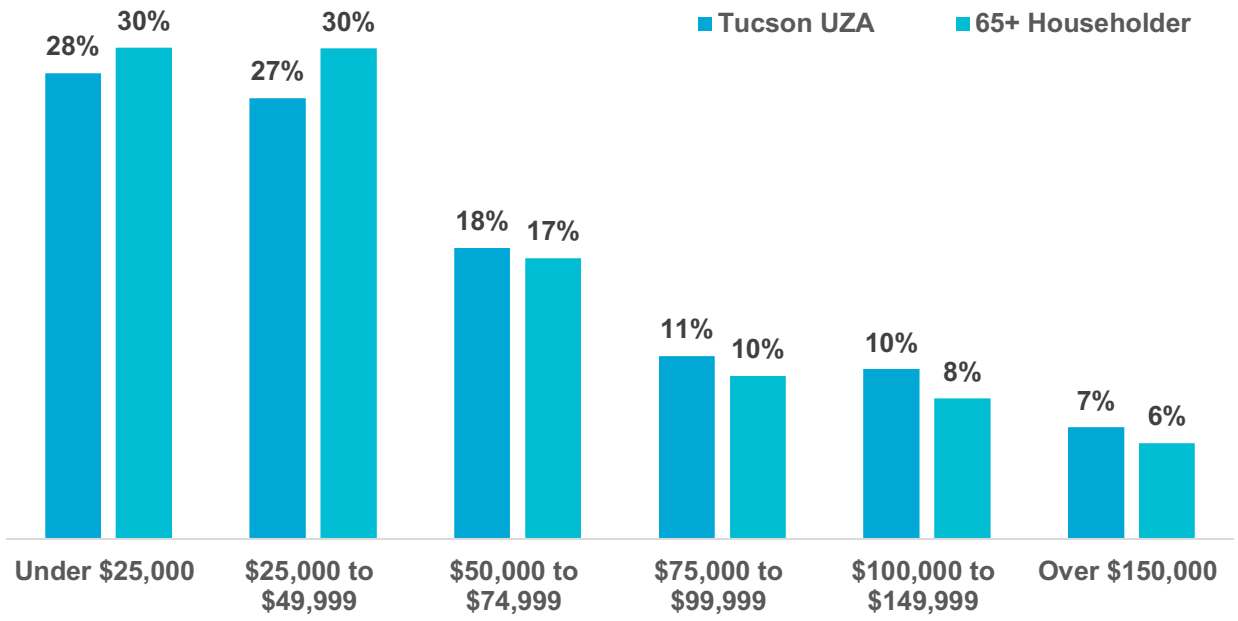
Figure 2.5 Median Household Income



Source: 2016 American Community Survey, 5-Year Estimate.

Three out of every ten householders above the age of 65 years have an income of less than $25,000, as shown in Figure 2.6. Compared to the overall population of the Tucson UZA, householders above the age of 65 years make up a greater share of the income levels below $50,000.

Figure 2.6 Income Distribution of 65+ Householders



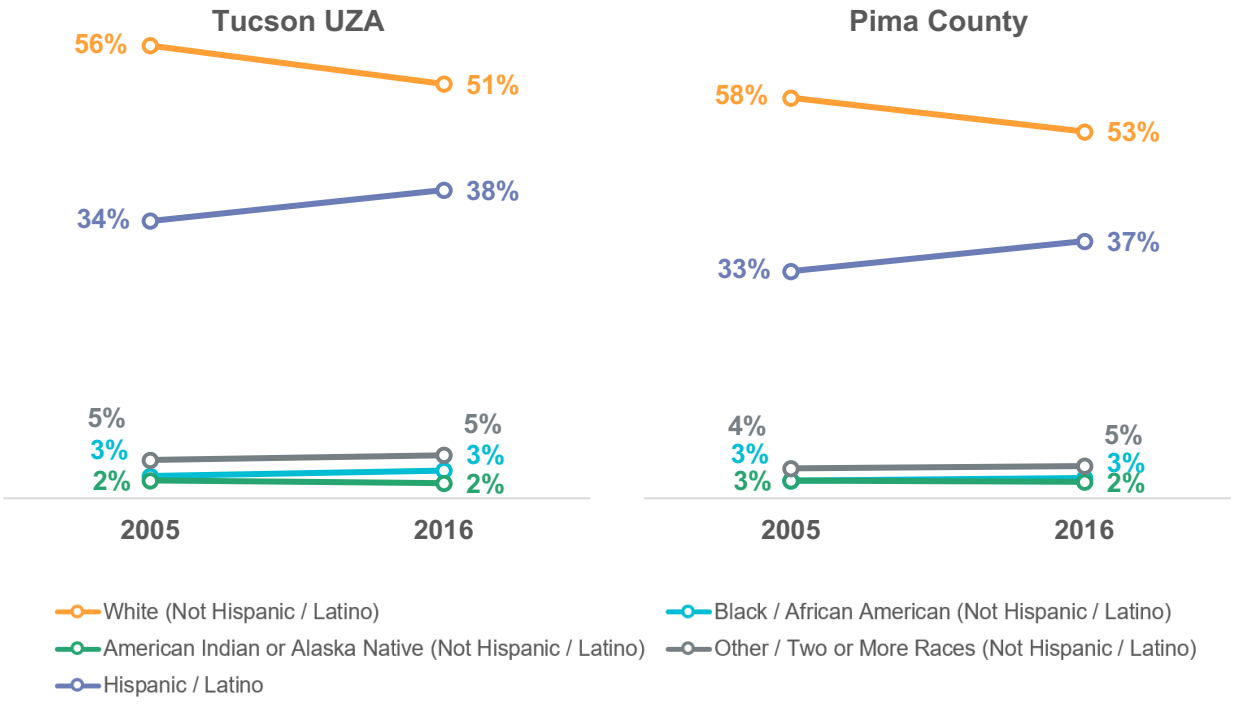
Source: 2016 American Community Survey, 5-Year Estimate.

2.3 Race and Ethnicity

The distribution of race and ethnicity between in the Tucson UZA and Pima County are fairly similar, with 51 percent and 53 percent of residents identifying as White (Non-Hispanic/Latino), respectively, as depicted in Figure 2.7. Since 2005, the share of minorities in the Tucson UZA, particularly the Hispanic/Latino population, has increased from 44 percent in 2005 and 49 percent in 2016. Although the study area is diverse as a whole, there is some separation between White and minority communities, with a high concentration of minority population in southern Tucson while a higher share of the non-minority population in northern Tucson, close to the Catalina Mountains, as shown in Figure 2.9.

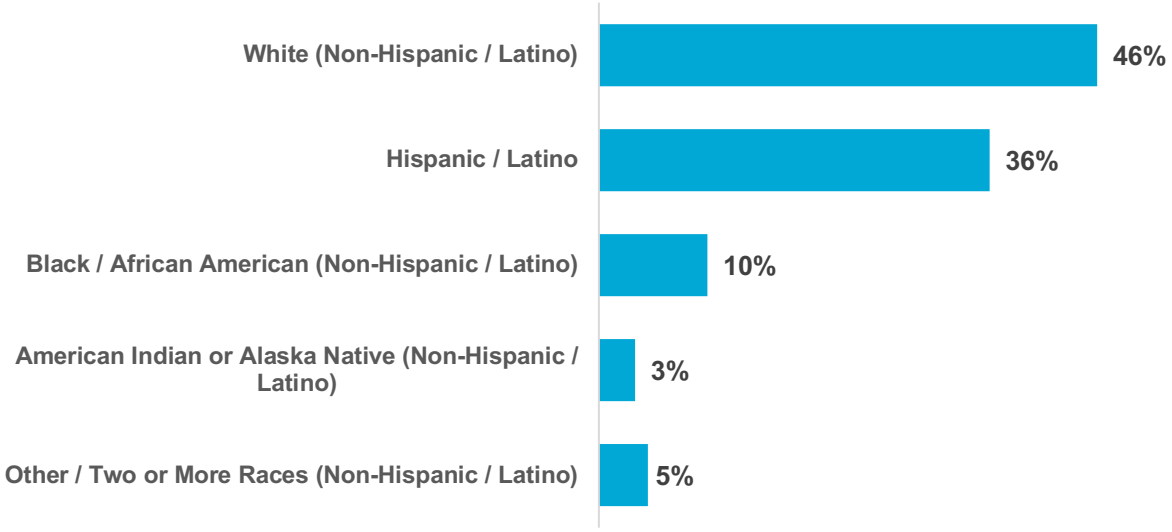
As shown in Figure 2.8, the racial and ethnic distribution of Sun Tran riders is slightly different from the overall population of UZA. Among riders, there is a slightly lower proportion of White (non-Hispanic/Latino), and a higher share of Black/African American and Other Races, representing 15 percent of existing transit passengers compared to seven percent of the Tucson UZA population.

Figure 2.7 Race & Ethnicity in Tucson UZA and Pima County (2005 and 2016)



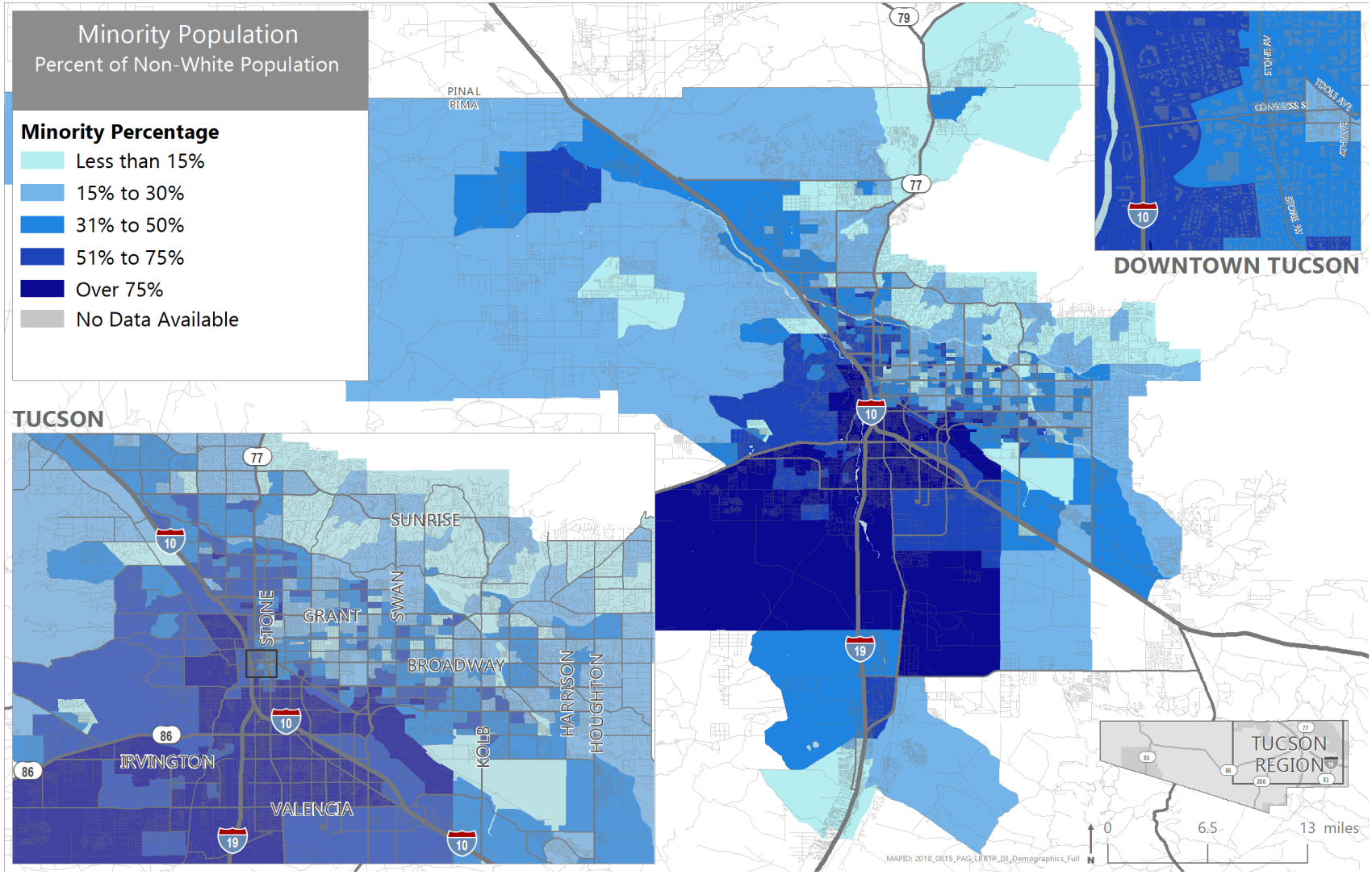
Source: U.S. Census, 2016 American Community Survey and IPUMS-USA

Figure 2.8 Race & Ethnicity of Existing Transit Passengers, 2016



Source: Sun Tran On-Board Transit Passenger Survey, June 2016.

Figure 2.9 Distribution of Minority Populations



Source: 2016 American Community Survey, 5-Year Estimate.

2.4 Age

The median ages in the Tucson UZA and Pima County are similar, at 37 and 38 years old, respectively.[15] Overall, the distribution of age cohorts between the two areas is comparable, though the Tucson UZA has a slightly higher share of the population under the age of 35 years old.

Recently, the age distribution of the Tucson UZA has shifted, with the **share of residents older than 65 increasing from 13 percent in 2005 to 17 percent in 2016** (Figure 2.10). This is higher than the nationwide trend of residents getting older, with 12 percent of the United States' population older than 65 years old in 2005 compared to 15 percent of the population in 2016.[16] As the Tucson UZA population ages, additional transportation services and options will be needed to support the independence and mobility of residents who lose the ability—or desire—to drive.

Likewise, the share of residents below 20 years old decreased from 28 percent in 2005 to 25 percent in 2016. However, the share of young adults (20 to 34 years old) has remained constant at 22 percent. Currently, this age cohort represents the Millennial generation, who are less likely to drive and are more likely to live in walkable neighborhoods than older adults.[17] Nationally, between 2001 and 2009, the average number of miles 16- to 34-year-olds drove decreased by 23 percent. Reasons include both fewer and shorter trips, as well as replacing driving with other modes. This travel behavior aligns with urban lifestyles, where access to public transportation, sidewalks, and bicycle infrastructure is higher.

The Millennial generation also represents 48 percent of existing transit passengers, well above the regional average, as shown in Figure 2.11. Similarly, only 5 percent of passengers are above 65 years old compared to 17 percent of the Tucson UZA.

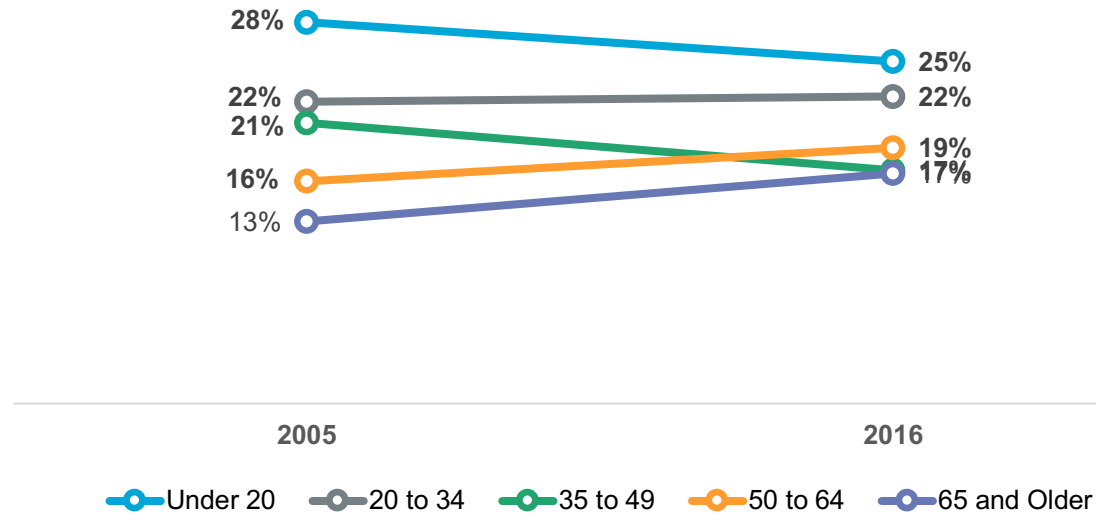
These differences in lifestyles impact where the Millennial generations live. As depicted in Figure 2.12, Millennials live closer to downtown Tucson, particularly in neighborhoods surrounding the University of Arizona, with lower shares of Millennials living in the northern and southern suburban neighborhoods.

[15] U.S. Census, 2016 American Community Survey and IPUMS-USA

[16] U.S. Census, 2005 and 2016 American Community Survey

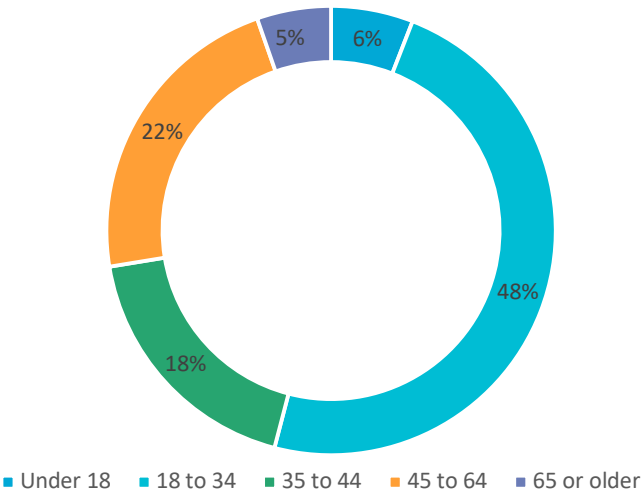
[17] https://uspirg.org/sites/pirg/files/reports/Millennials%20in%20Motion%20USPIRG.pdf

Figure 2.10 Age Distribution in Tucson UZA, 2005 to 2016



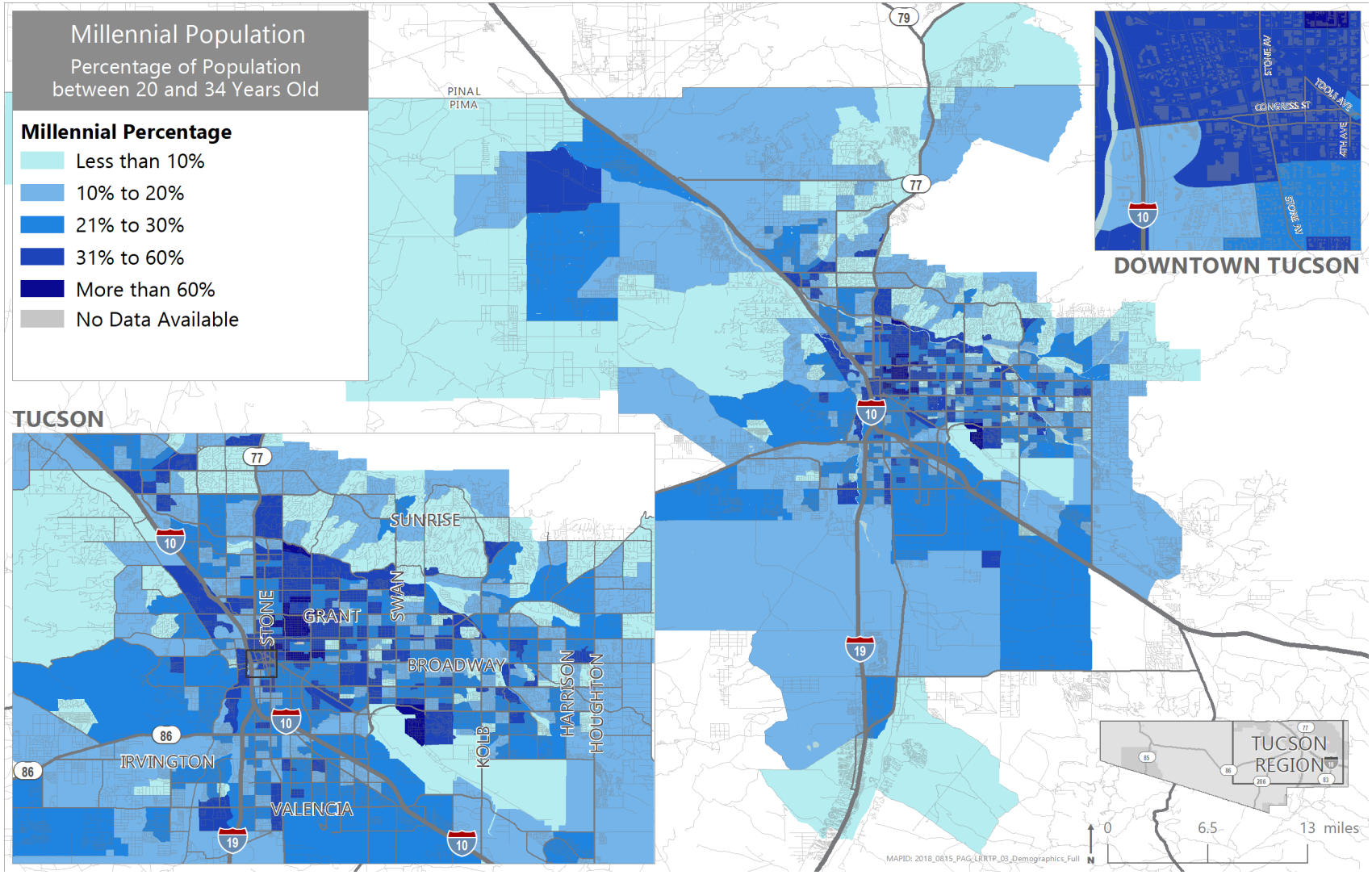
Source: IPUMS-USA. Steven Ruggles, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek. IPUMS USA: Version 8.0 [dataset]. Minneapolis, MN: IPUMS, 2018. https://doi.org/10.18128/D010.V8.0

Figure 2.11 Age Distribution of Existing Transit Passengers, 2016



Source: Sun Tran On-Board Transit Passenger Survey, June 2016.

Figure 2.12 Distribution of Millennial Population (20 to 34 years old)



Source: 2016 American Community Survey, 5-Year Estimate.

2.5 Disability

Individuals with a disability may require additional services and infrastructure to remain mobile.[18] Public, private, and nonprofit transportation services are critical for individuals who may not own or drive a personal vehicle. Accessible infrastructure, such as sidewalks, curb ramps and crosswalks for persons who use a wheelchair, are needed for mobility and connectivity to destinations. The percentage of individuals with a disability is fairly even between the Tucson UZA and Pima County at 15 and 16 percent, respectively.[19] This is higher than the eight percent of existing transit passengers with a disability, although it is important to note that this figure excludes passengers of Sun Van.[20] It is also higher than the national average of 13 percent of the population with a disability.[21] This may be attributed to a higher share of Tucson UZA residents over 65 years old (see Section 2.4). Since 2005, the percentage of individuals with a disability has remained fairly steady with a few fluctuations. The location of individuals with a disability is fairly scattered as shown in Figure 2.13, with high concentrations north of the Tucson International Airport and north of downtown Tucson near the Arizona State Schools for the Deaf and the Blind.

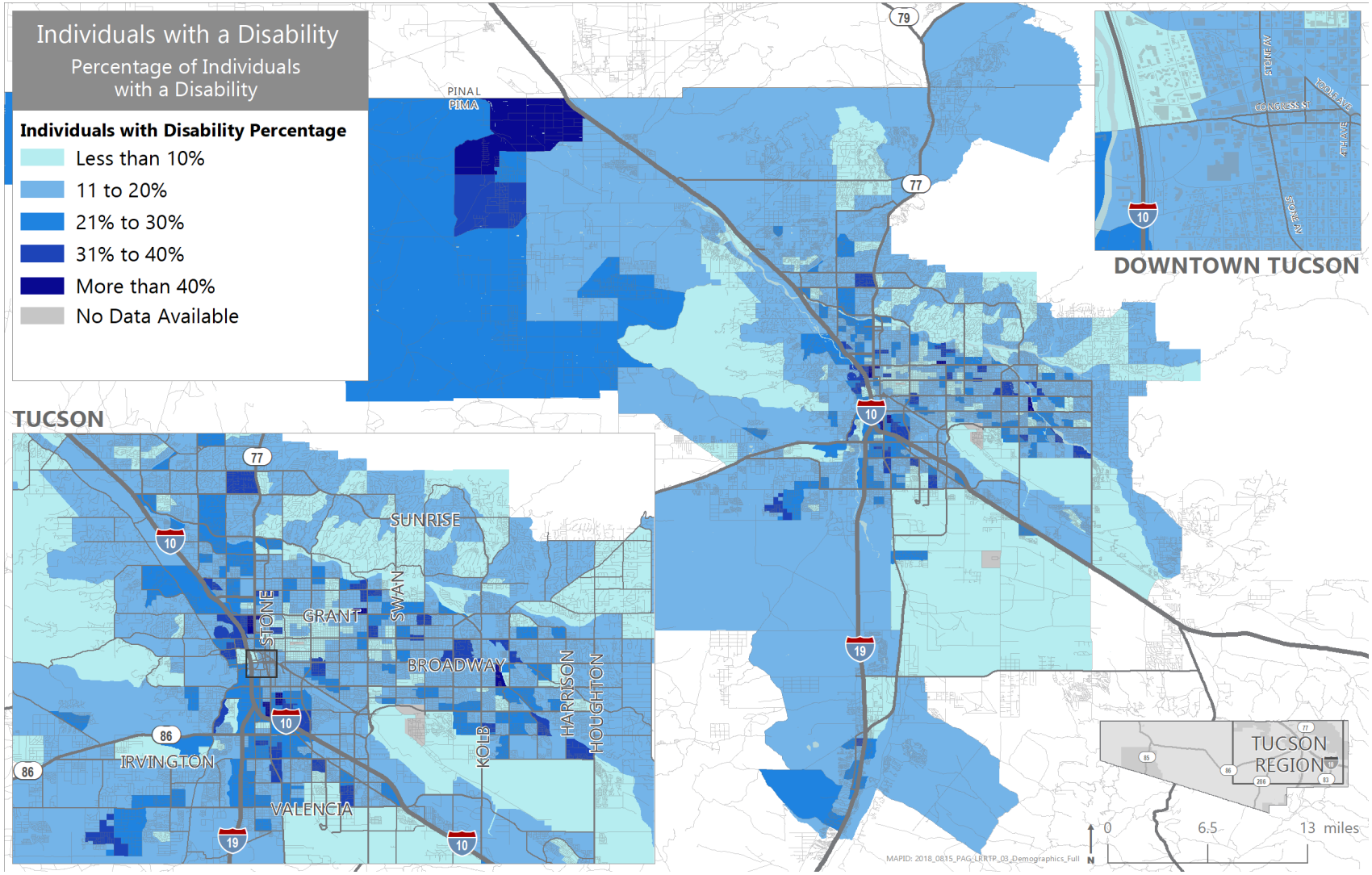
[18] Individuals with a disability includes: hearing difficulty, vision difficulty, cognitive difficulty, ambulatory difficulty, self-care difficulty, and independent living difficulty.

[19] 2016 American Community Survey, 5-Year Estimate.

[20] Sun Tran On-Board Transit Survey, June 2016.

[21] 2016 American Community Survey, 5-Year Estimate.

Figure 2.13 Distribution of Individuals with a Disability



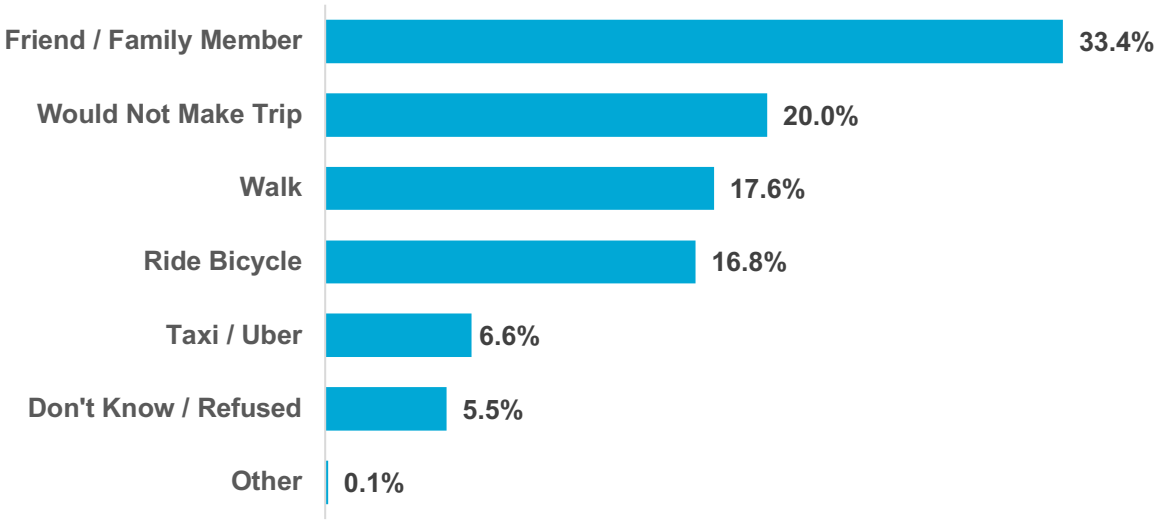
Source: 2016 American Community Survey, 5-Year Estimate.

2.6 Vehicle Ownership

Vehicle ownership within the Tucson UZA and Pima County has remained fairly consistent since 2010. In 2010, approximately 9.2 percent of households in Tucson UZA and 7.9 percent of households in Pima County did not have access to a personal vehicle. This percentage has increased about five percent in Tucson UZA to 9.7 percent in 2016 while Pima County slightly increased to 8.1 percent. The continued growth in the population in addition to an increased share of households without access to a vehicle equates to more of the population relying on public transportation and other alternative transportation modes for traveling throughout the region.

Over half of existing transit passengers do not have access to a vehicle, much higher than the regional average.[22] This makes a large share of passengers fairly dependent on the local public transportation network. Of those without a household vehicle, if public transportation was not available, approximately 33 percent would ask a friend or family member for a ride, 34 percent would walk or ride a bicycle, while 20 percent would not take the trip at all.

Figure 2.14 Alternative Transportation Mode if Sun Tran was not Available for Existing Transit Passengers without a Personal Vehicle



Source: Sun Tran On-Board Transit Passenger Survey, June 2016.

2.7 Trends and Conclusions

Since 2000, both the Tucson Region and Pima County have experienced modest but steady growth. The increase in population in the region creates a need for more jobs, more services, and more transportation options to move residents in and around the region. These trends in higher population density and lower household income have improved the potential for public transportation to attract ridership within the city limits of Tucson, but their magnitude has been modest and projected trends indicate similar future patterns.

[22] Sun Tran On-Board Transit Survey, June 2016.

Several key household characteristics influence transit ridership in the region. Overall, the median household income in the Tucson UZA is lower than the state and national averages, though poverty levels have remained fairly steady in recent years. The percent of households without a personal vehicle is on the rise with **one of every 10 households without access to a vehicle**, with higher concentrations of households located north of downtown Tucson. Research has shown that income has a strong correlation with public transportation usage, where transit usage is highest among low-income households.[23] Many low-income households have no access to vehicles and may rely on public transportation for mobility in and around the city.

The Tucson UZA is also growing older, with the share of individuals 65 years old or older increasing from 13 percent in 2005 to 17 percent in 2016. the share of adults between 20 to 34 years old has remained steady during the same time period and represents a larger population at 22 percent. Research suggests that 20 to 34-year-olds (the current Millennial generation) are more likely to travel by bicycling and transit, instead of driving; however, it is unknown if this trend will persist as the generation ages.[24] In the Tucson region, Millennials tend to be concentrated closer to downtown Tucson, in areas with higher density and existing transit coverage. On the other hand, individuals over 65 years old are more likely to live outside of the Tucson city limits, where transit service is more sparse; for these residents to become likely public transit riders, senior housing will need to be dense enough to make walk access to transit very convenient (less than ¼ mile) or require shared mobility modes to ferry elderly residents to their destinations.[25]. The most feasible service concepts, however, will be provided in the next phase of this study

[23] https://www.fhwa.dot.gov/policy/otps/travel_behavior_research_scan.pdf

[24] https://uspirg.org/sites/pirg/files/reports/Millennials%20in%20Motion%20USPIRG.pdf

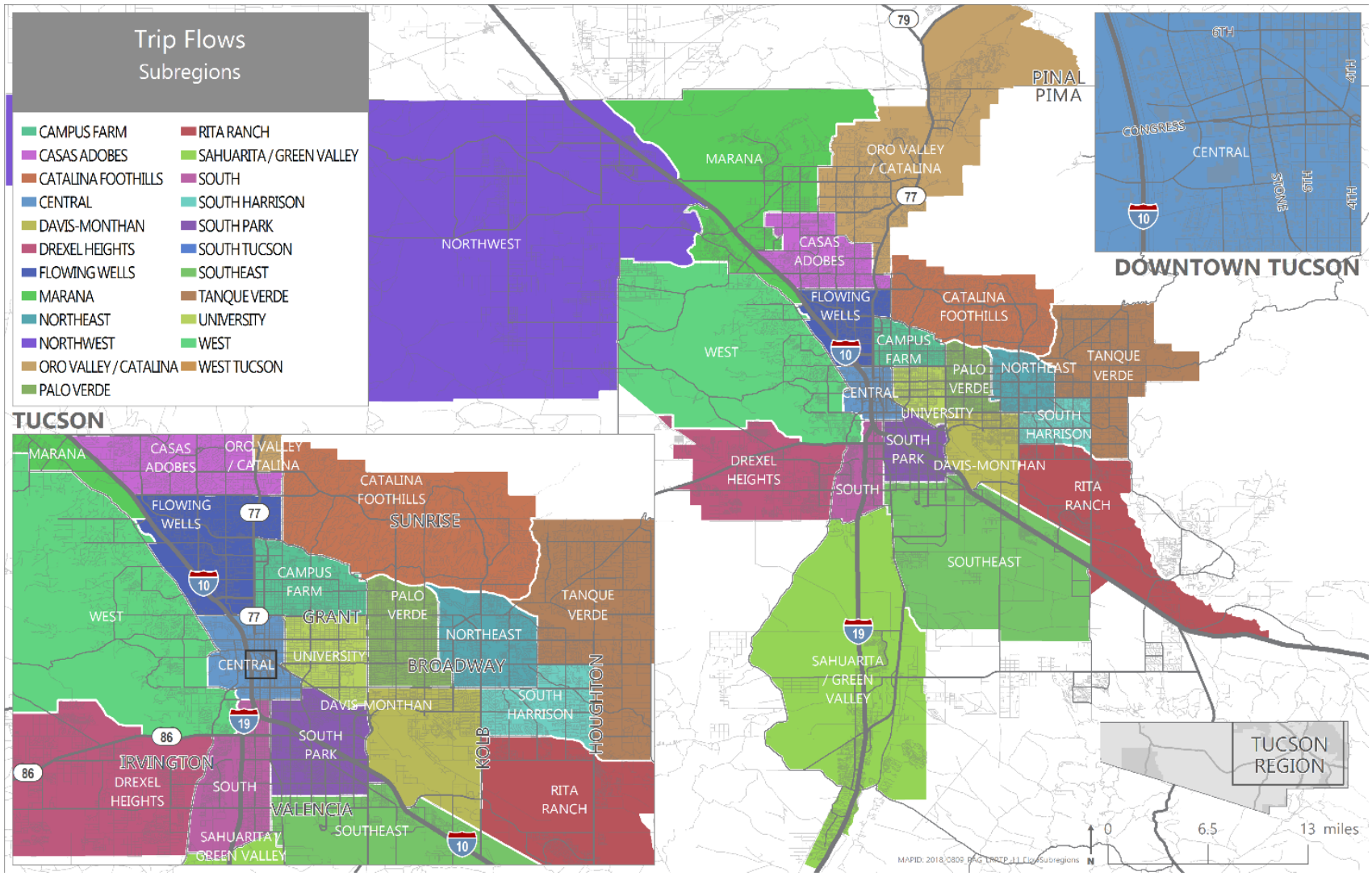
[25] https://www.fhwa.dot.gov/policy/otps/travel_behavior_research_scan.pdf

3.0 Travel Patterns

Across the Tucson region, millions of trips combine to represent overall travel demand. Many factors influence when those trips are taken and by which mode, or combination of modes. Some trips are more conducive to choosing transit while others exhibit conditions that prove transit to be too challenging.

This section uses both the Pima Association of Governments Travel Demand Model and the Sun Tran On-Board Transit Passenger Survey to understand regional travel patterns. The Travel Demand Model is designed to provide estimates of travel patterns, based on weekday trips, and mode choice. Household travel surveys provide characteristics of trips that are modeled across the region. The Sun Tran On-Board Transit Passenger Survey provides travel behavior data specific to transit users. To analyze general patterns of trip flows, the study area was divided into 21 subregions, as shown in Figure 3.1.

Figure 3.1 Trip Flow Subregion Definition



Source: Pima Association of Governments Travel Demand Model Data, 2017.

Using information from the Travel Demand Model, this analysis illustrates where and when transit is competitive today and where the greatest market potential exists for transit by describing the following dimensions:

- Travel behavior;
- Travel time competitiveness; and
- Trip flows.

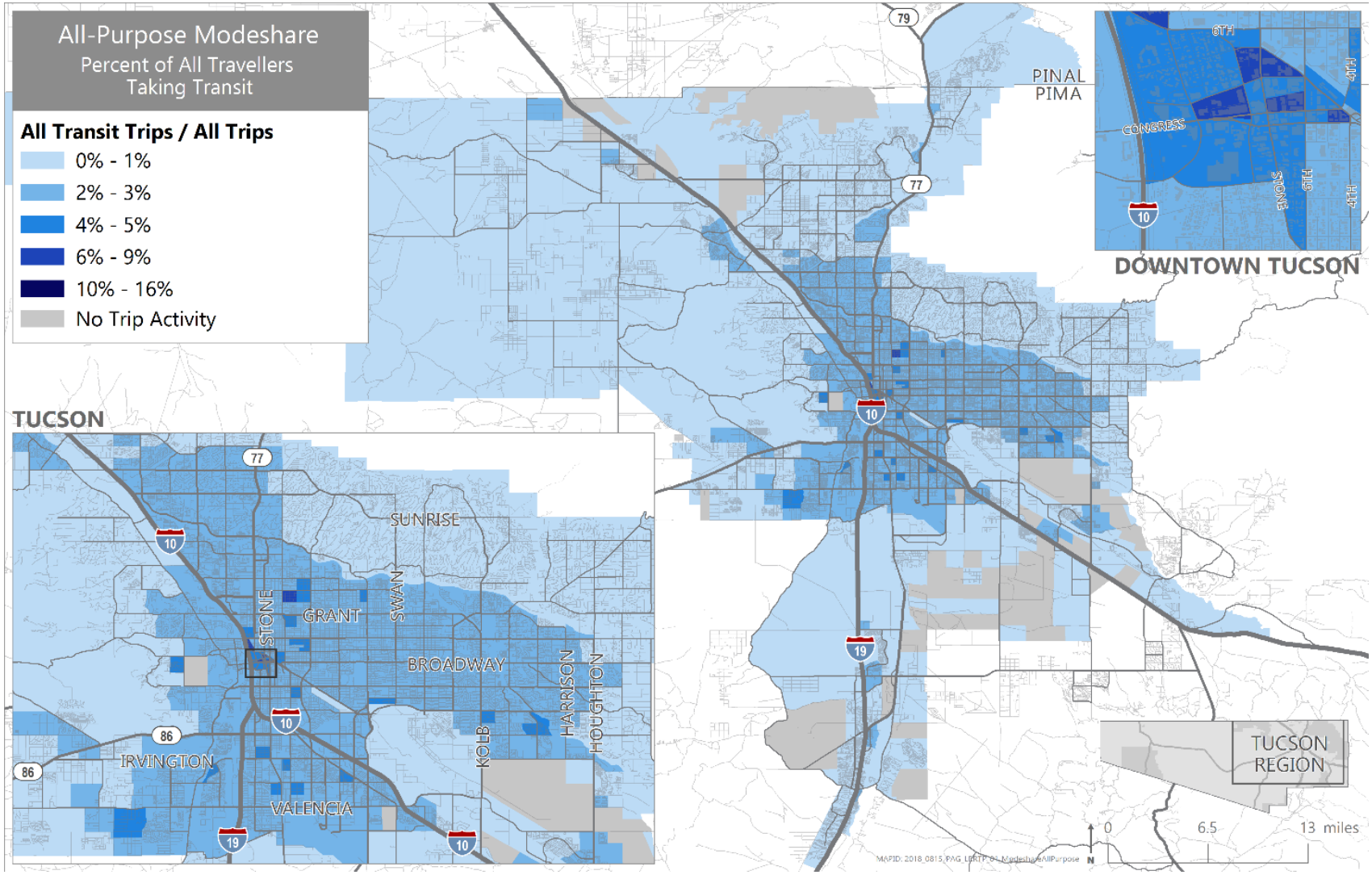
3.1 Travel Behavior

To understand the travel behavior of all weekday travel in the region, and travel specific to those who take transit, this section explores the following trip characteristics:

- The mode selected to complete the trip (walking, bicycle, transit, or automobile);
- The purpose of the travel (home to/from work; home to/from school; home to/from shopping; home to/from all other destinations; and hon-home to/from other destinations);
- The trip distance; and
- The time of day (peak, defined as the hours between 6:30 to 8:30 AM and between 4 to 6 PM, and off-peak travel defined as the hours between 8:30 AM and 4 PM and 6 PM to 6:30 AM).

These factors provide insights into how the transportation system operates and how the transit network is utilized. **Overall, within the study area, 1.5 percent of all trips are taken by transit.** Figure 3.2 shows the percentage of residents taking transit for any trip purpose within the Tucson region. The transit mode share reaches above five percent in the neighborhoods within the downtown Tucson and University areas.

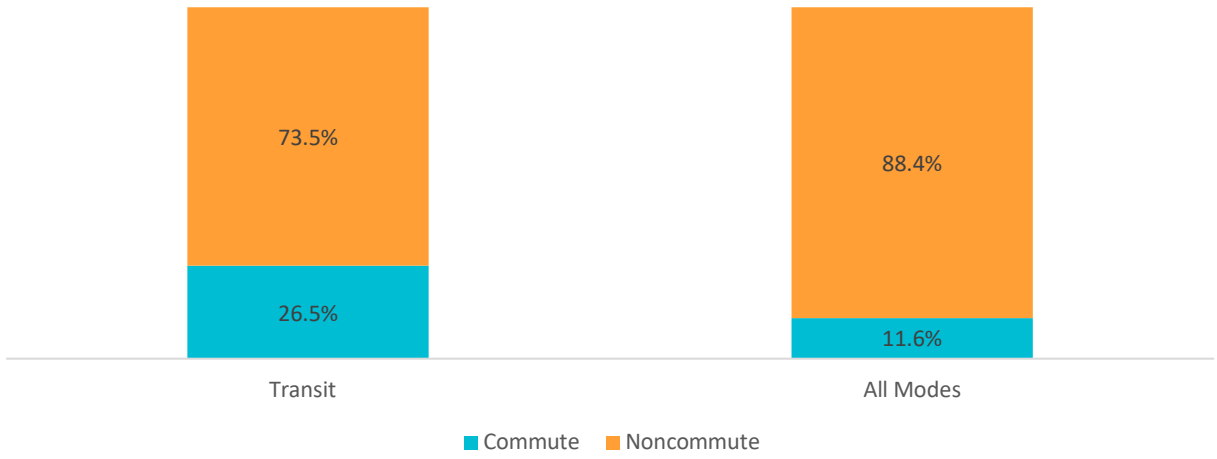
Figure 3.2 All-Purpose Mode Share, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.
Note: Mode share is calculated based on transit trips and total trips originating in each TAZ.

To analyze trip purposes, trips are divided into commute trips (travel to work from home and from home to work) and non-commute trips (travel to and from school, shopping, trips taken during work, or other destinations). Commute trips represent a significant portion of transit ridership. **As shown in Figure 3.3, commute trips within the region represent 11.6 percent of all trips but represent 26.5 percent of all transit trips.**

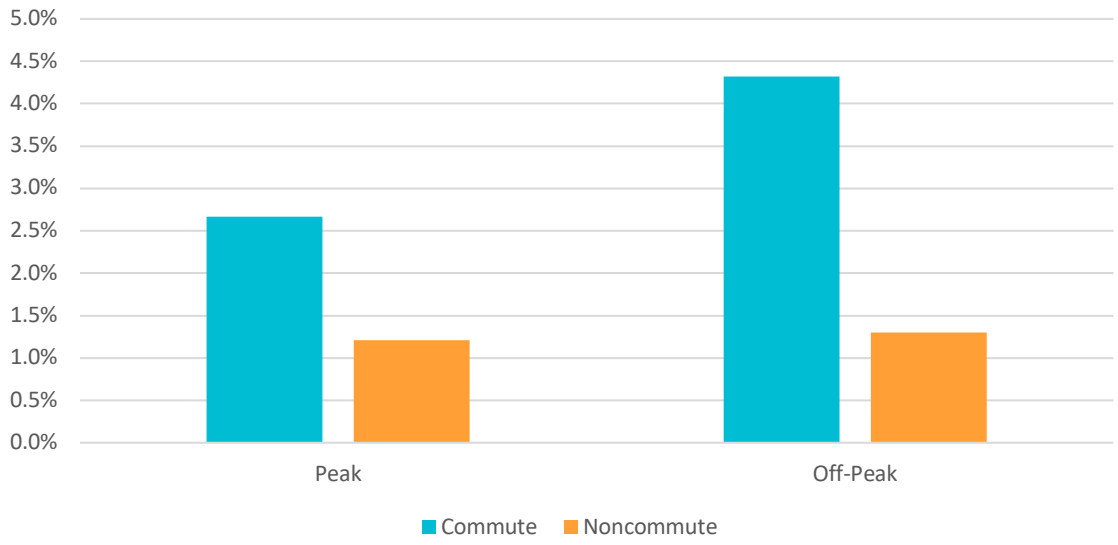
Figure 3.3 Share of Commute Trips by Transit and All Modes, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

There is a significant difference in the transit mode share between peak and off-peak commute trips, as shown in Figure 3.4. Over four percent of off-peak commute trips are taken by transit, while almost three percent of peak commute trips are taken by transit.

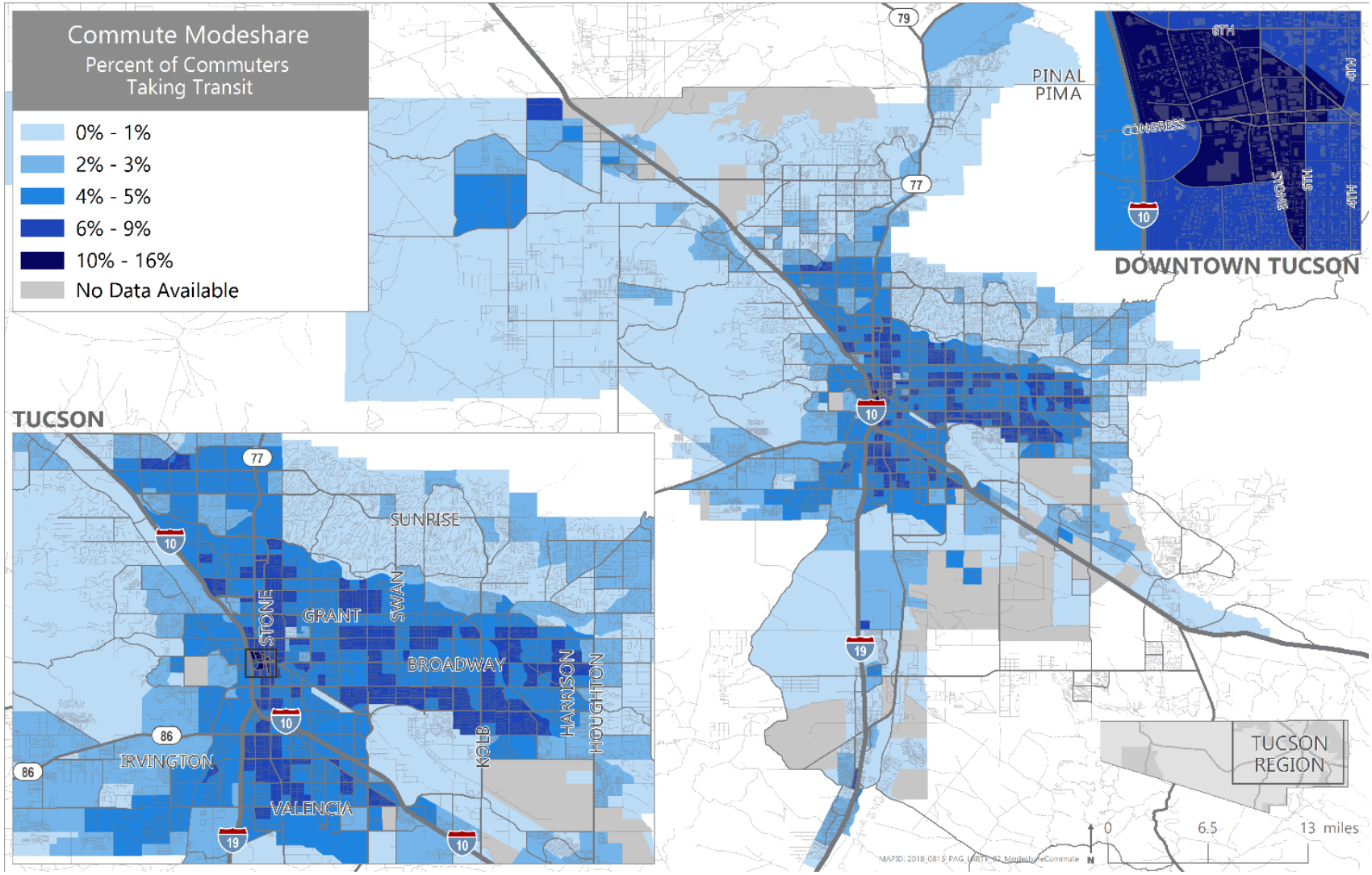
Figure 3.4 Share of Transit Trips by Purpose & Time of Day, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

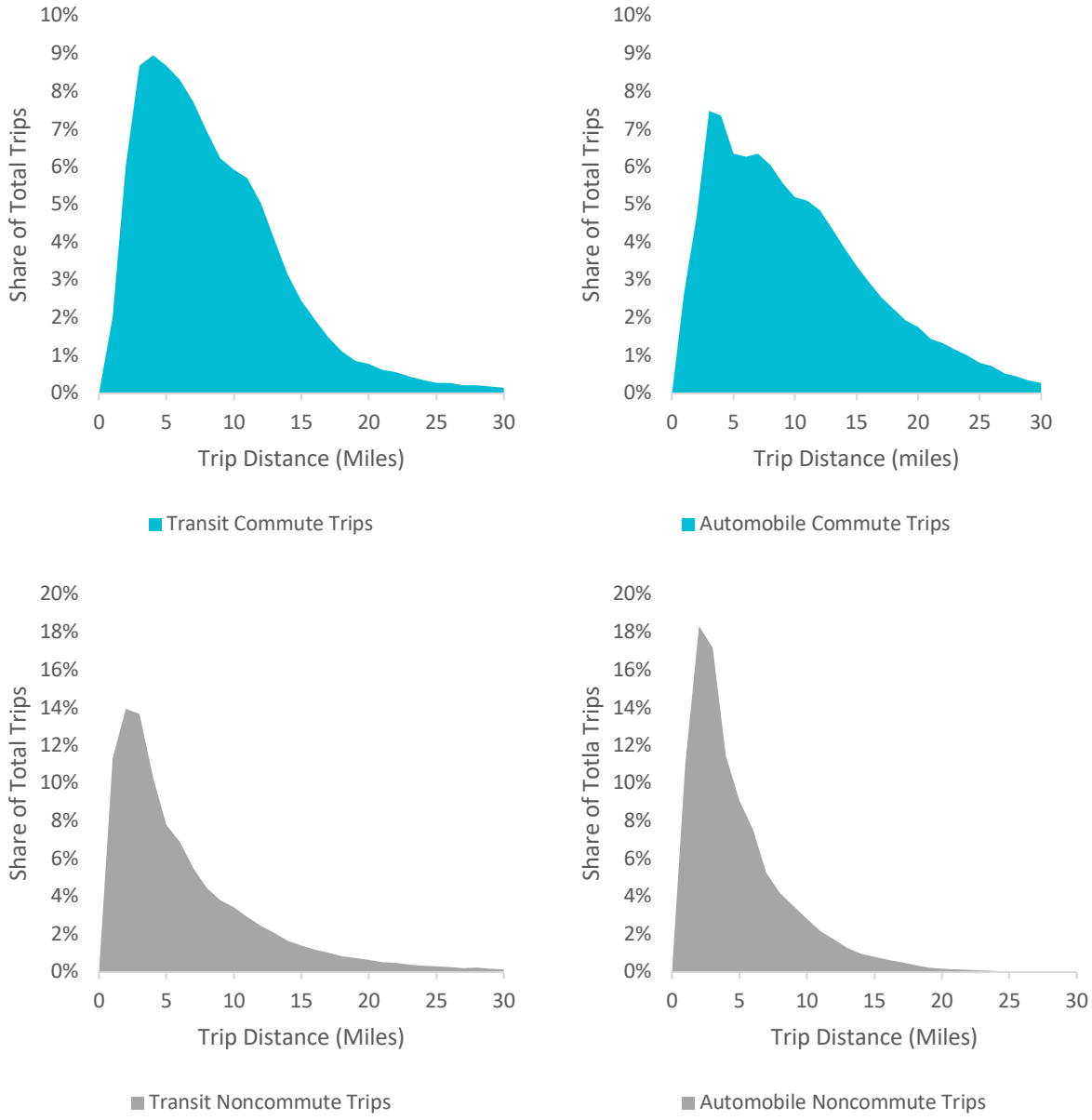
In the Tucson region, 3.5 percent of commute trips are taken on transit (compared to 1.5 percent of all trips). The tendency to use transit for commute trips varies by neighborhood as shown in Figure 3.5. The transit commute mode share reaches above ten percent in the neighborhoods within the downtown area including Armory Park, Barrio Anita, Barrio Viejo, El Presidio, and Downtown.

Figure 3.5 Commute Mode share, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

Figure 3.6 Trip Distance by Mode and Purpose, 2017

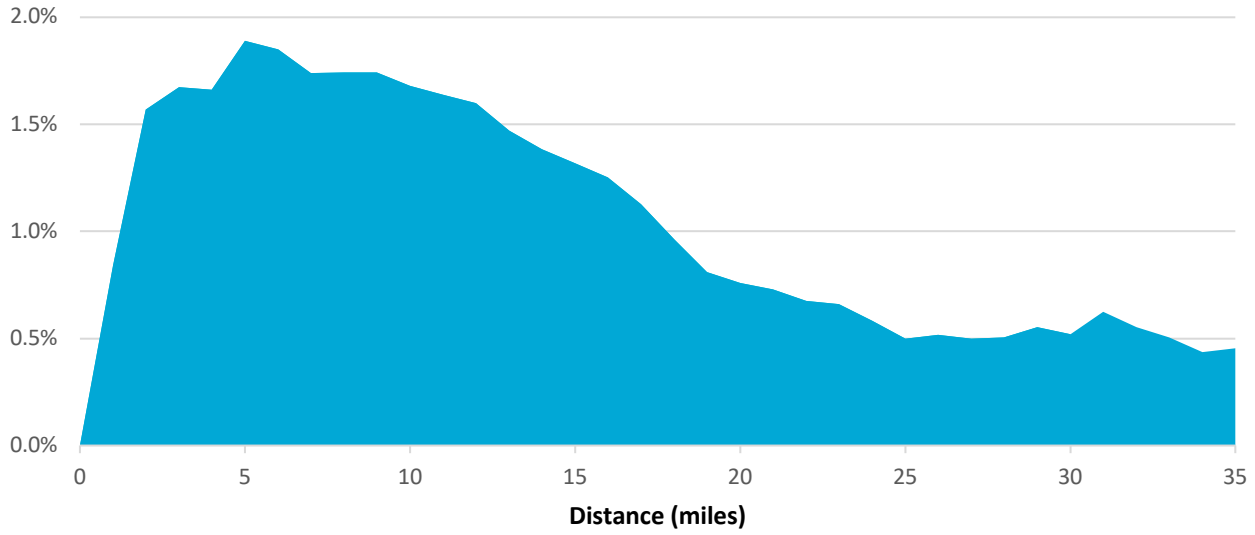


Source: Pima Association of Governments Travel Demand Model Data, 2017.

As shown in Figure 3.6, the region's commute trips tend to be longer than noncommute trips. The average commute distance for a commute trip is 8.5 miles (or a median trip distance of 7.5 miles), while the average trip distance for noncommute purposes is slightly over five miles (or a median trip distance of 3.4 miles). The distance for transit is slightly shorter with the average commute trip by transit is eight miles and the average noncommute trip by transit is 4.5 miles.

Transit trips represent a low percentage of all trips, regardless of the trip distance. As shown in Figure 3.7, transit trips represent less than one percent of all trips less than one mile. Almost two percent of all trips between five and ten miles in length are taken by transit.

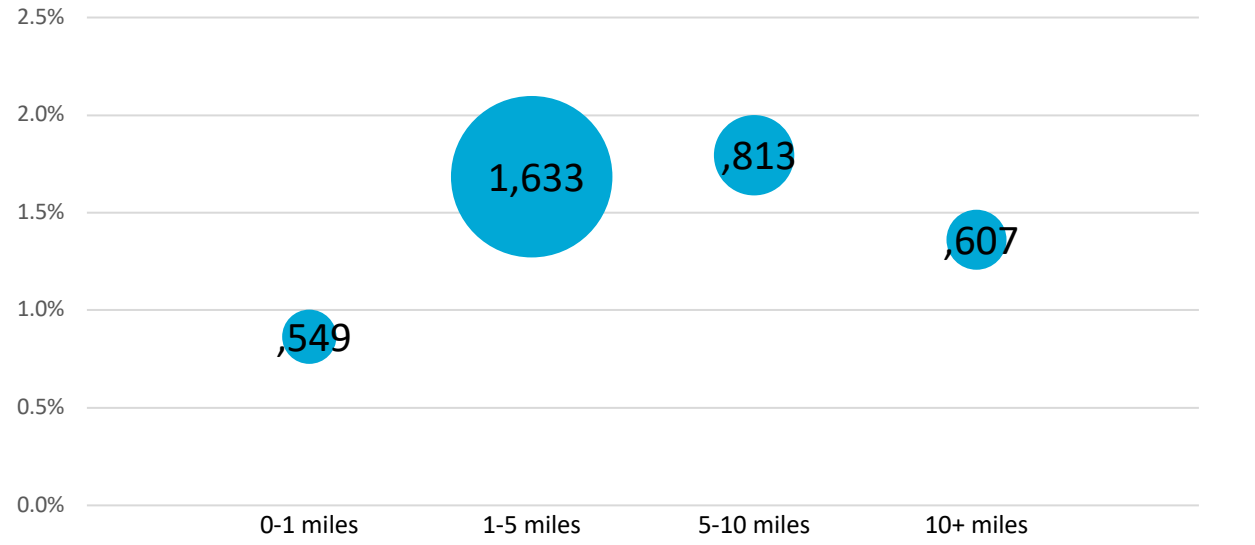
Figure 3.7 Transit Market Share by Distance, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

Comparison of the share of trips by distance taken by transit to the trips by distance of all modes shows that the difference in transit share does not correspond to the difference in total trip share. **Forty-five percent of all trips are between one and five miles in length**, but the share of transit trips within that distance is around 1.6 percent (Figure 3.8).

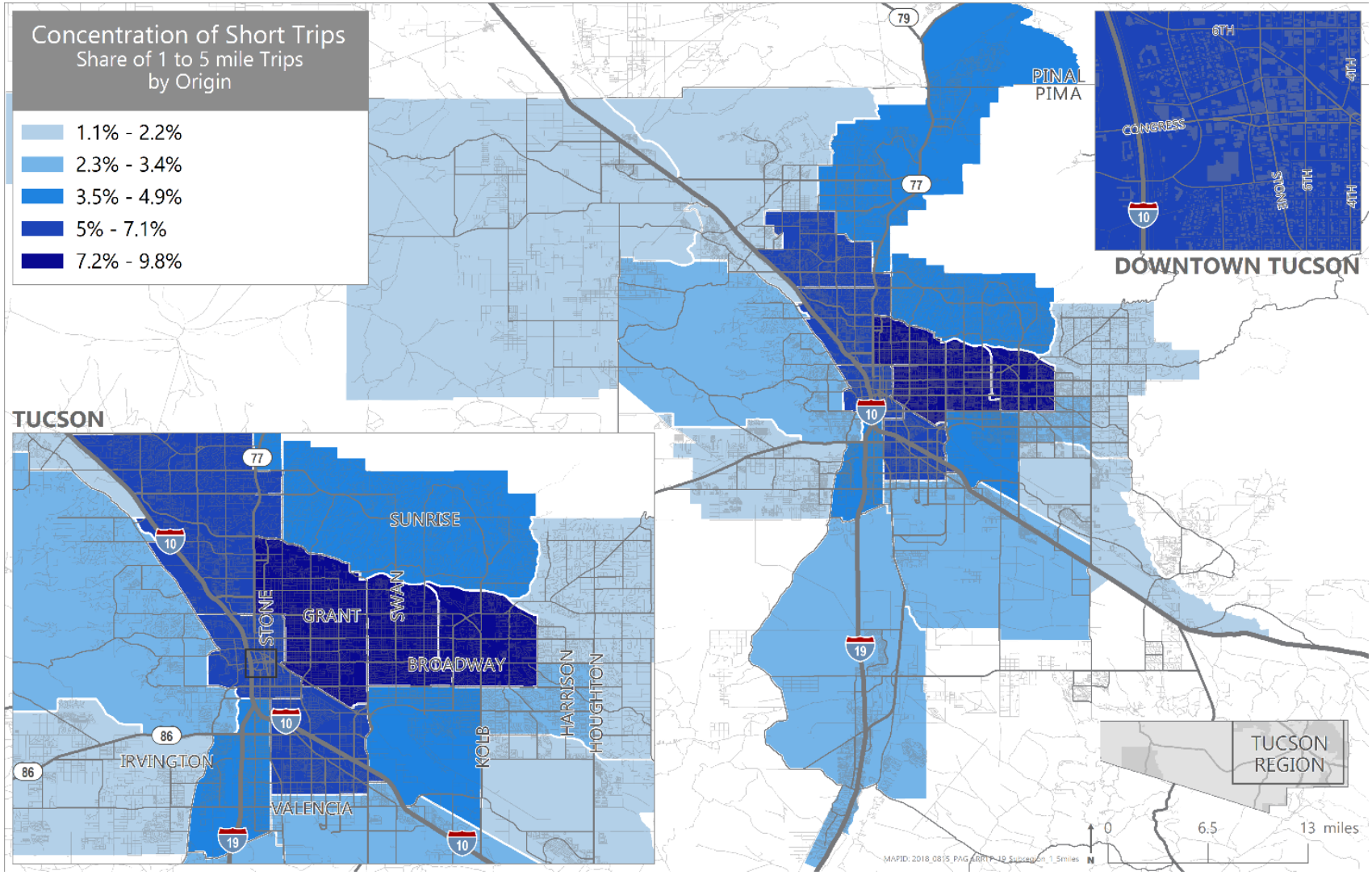
Figure 3.8 Transit Market Share by Distance & Total Trips (in Thousands), 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

As shown Figure 3.9, the origin of the region's short trips, defined as one to five miles in length, are concentrated within the five subregions including Campus Farm, Northeast, Palo Verde, South Park, and University. Trips within and between these subregions represent one out of every five trips in the region.

Figure 3.9 Concentration of Short Trips

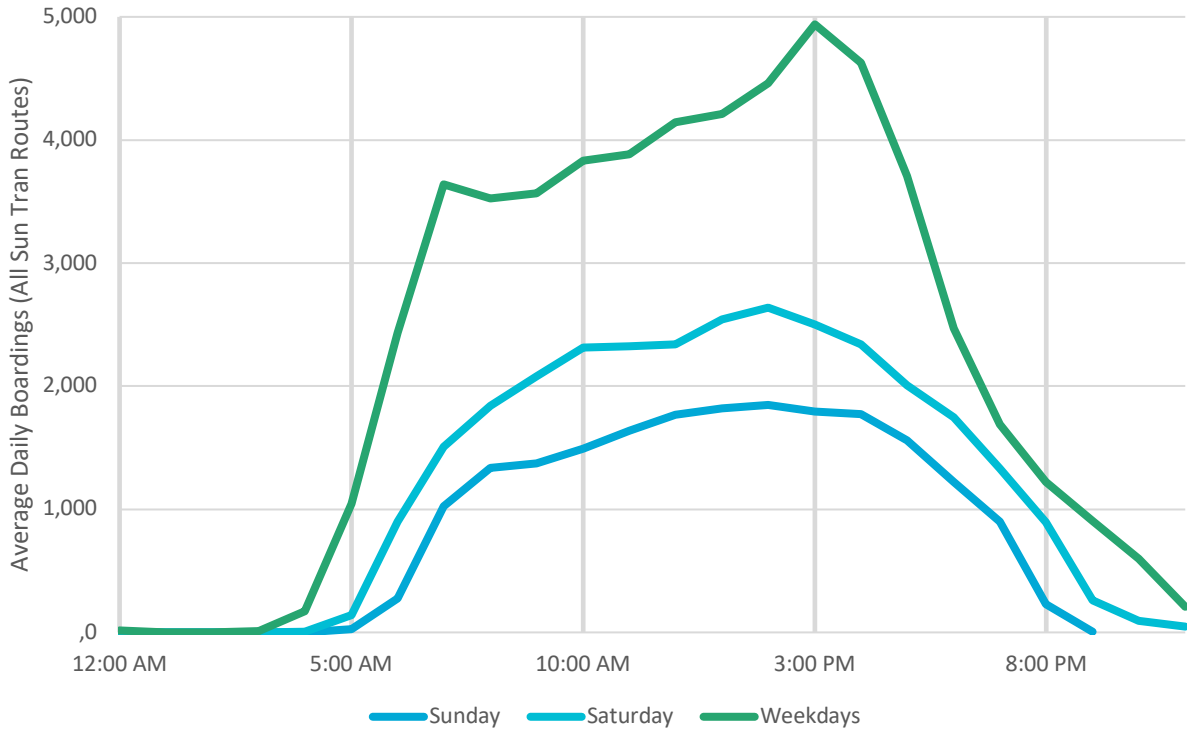


Source: Pima Association of Governments Travel Demand Model Data, 2017.

Another key attribute of travel is the time of day in which it occurs. In the Tucson region, peak travel is defined as the hours between 6:30 to 8:30 AM and between 4 to 6 PM. Off-peak travel is defined as the hours between 8:30 AM and 4 PM and 6 PM to 6:30 AM. During the peak periods, approximately 31 percent of all travel occurs in four hours.

As shown in Figure 3.10, transit trips occur steadily throughout the day, with 40 percent of Sun Tran ridership occurring between the hours of noon to 5 PM. Transit trips peak in the morning around 7 AM and in the afternoon the peak occurs around 3 PM.

Figure 3.10 Sun Tran Average Ridership by Time of Day, March 2018



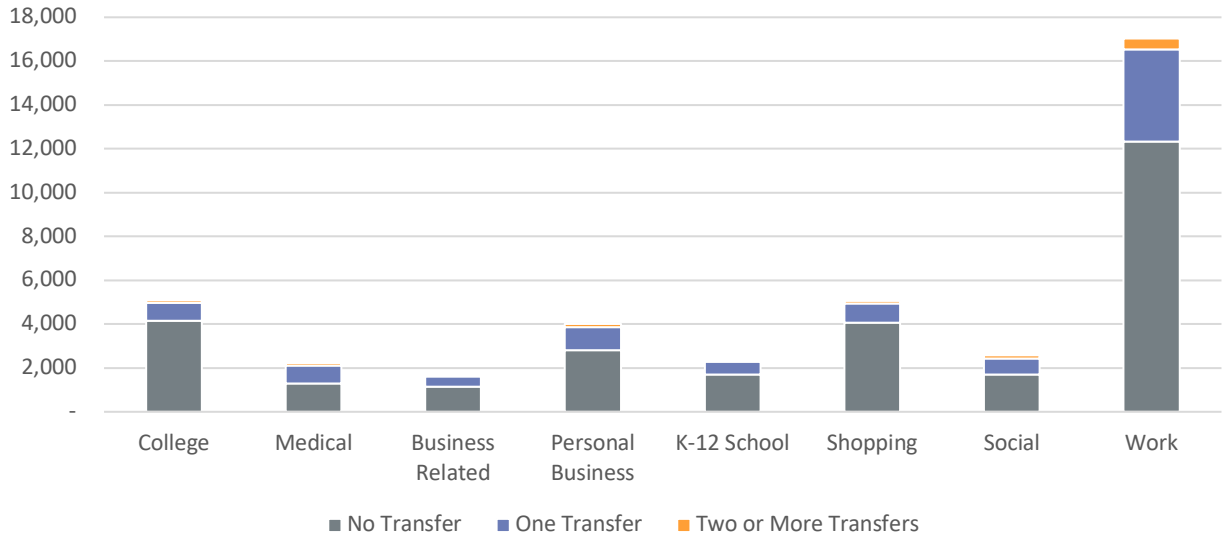
Source: Sun Tran Automatic Passenger Counts, March 2018.

3.2 Travel Time Competitiveness

Travel time is a key element of travel decisions, and ultimately, the travel experience. For residents with access to transit, the time required to complete a trip is a major determining factor for whether or not a resident decides to use transit. An evaluation of travel time highlights where transit is competitive in serving trip demand to and from downtown Tucson as well as to and from the University of Arizona.

When comparing automobile travel time to transit travel time it is important to consider each component of time required to complete a transit trip. Transit travel time includes the time it takes to travel to the stop, the time in the vehicle, the stops along the destination and any transfers required. According to the On-Board Transit Passenger Survey, the majority of transit trips, approximately 74 percent, do not require a transfer. Figure 3.11 depicts the number of transfers required for various trip purposes. Seven out of every ten transit trips taken to and from work do not require a transfer. Transit trips taken to and from college and shopping have low percentages of transfers with only two out of every ten trips requiring a transfer.

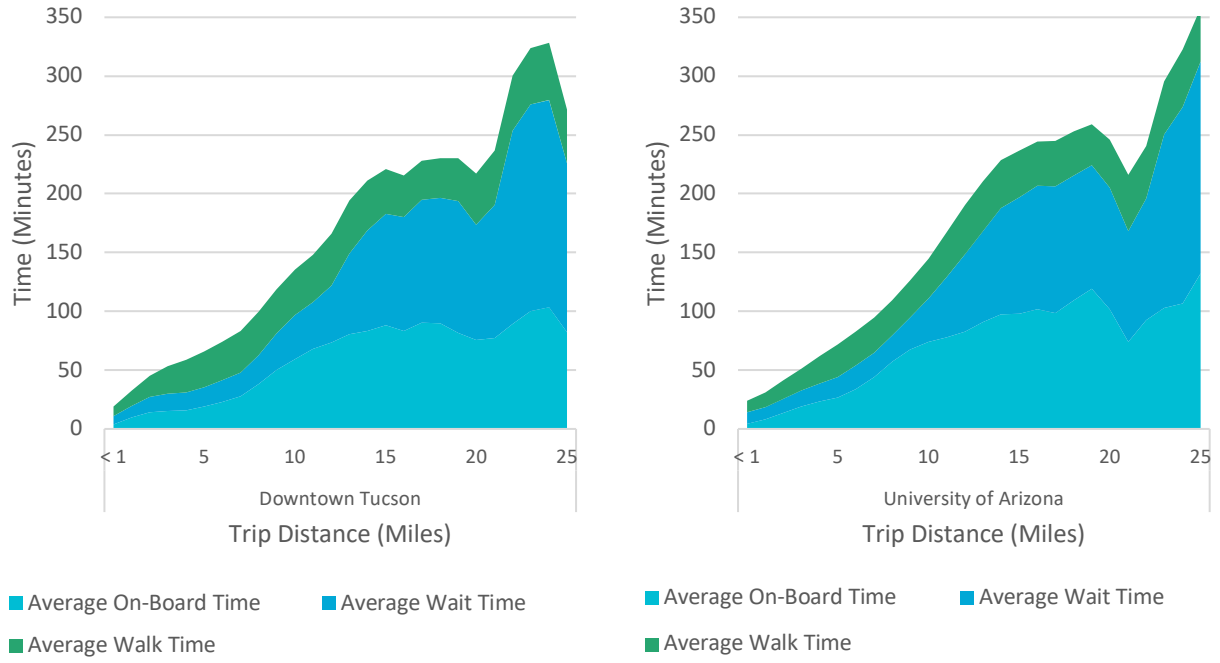
Figure 3.11 Total Transfers Required by Trip Purpose, 2016



Source: Sun Tran On-Board Transit Passenger Survey, June 2016.

Figure 3.12 depicts the travel time to and from downtown Tucson and the University of Arizona by various transit trip distances. For transit trips between one and five miles in distance, waiting and walking encompasses an average of 70 percent of the total trip time, 24 percent is spent waiting and 46 percent is spent walking. Passenger sensitivity to wait time and on-board travel time differs by distance, walk and wait time is critical for shorter trips, while on-board travel time is important for longer trip distances.

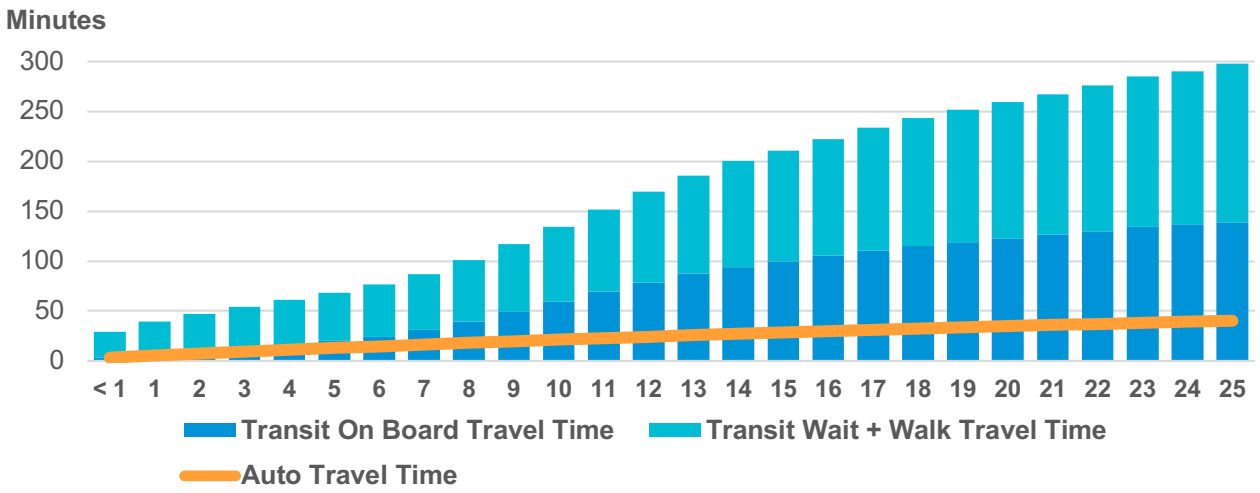
Figure 3.12 Transit Travel Time by Trip Distance, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

The travel time difference between automobile and transit varies significantly by trip distance. While the on-board transit travel time is relatively competitive with comparable automobile travel times for trips under seven miles, the walk and wait times add significant travel time to the transit trip. The most competitive trips by distance for transit are between five and eight miles in length, although those are still significantly longer than a comparable automobile trip.

Figure 3.13 Automobile and Transit Travel Time by Distance, 2017

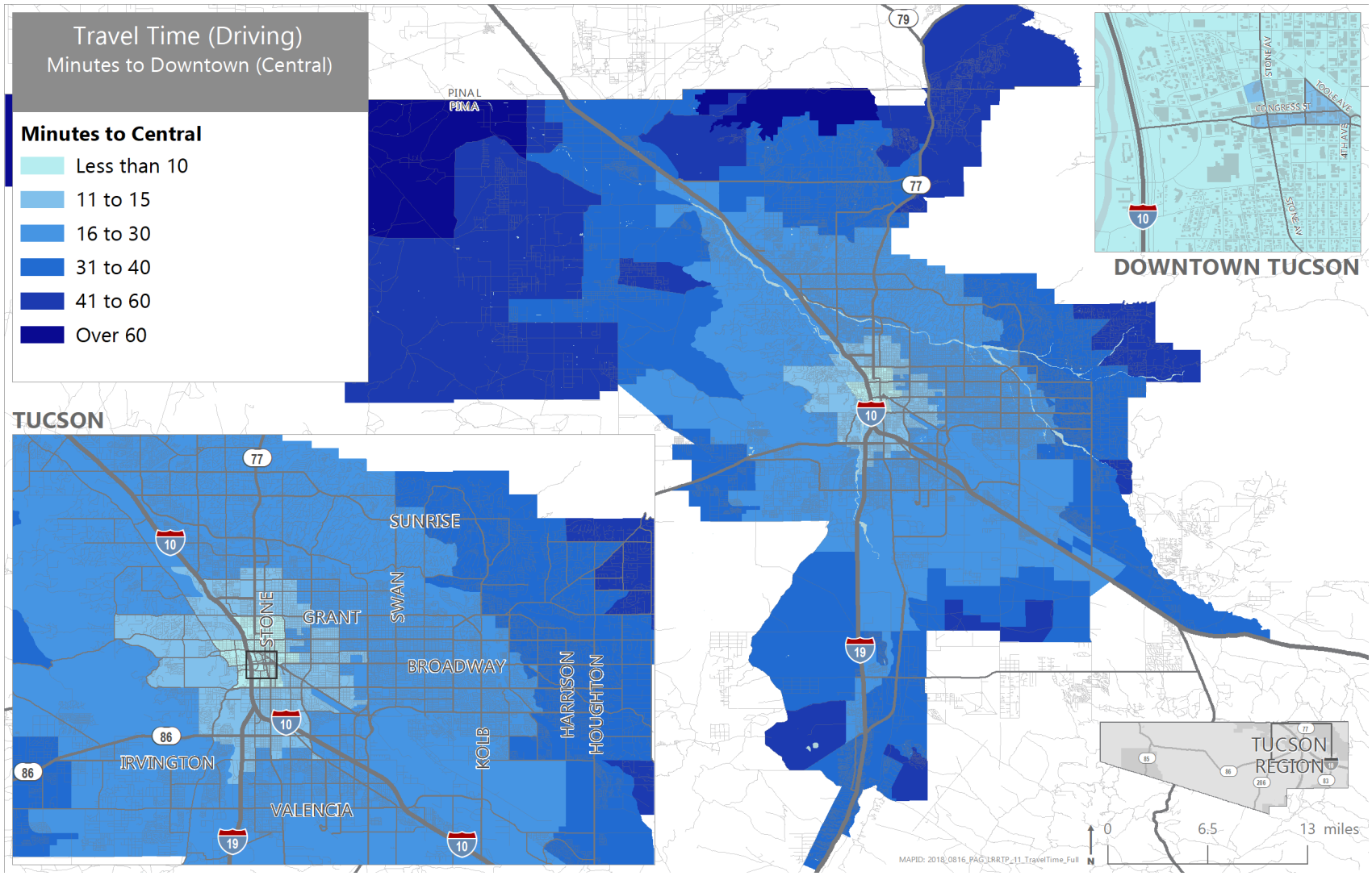


Source: Pima Association of Governments Travel Demand Model Data, 2017.

The travel time to downtown Tucson by automobile is depicted in Figure 3.14. The majority of the study area has relatively quick access to downtown Tucson by automobile. There is a significant difference in travel time by mode. To reach downtown by transit, the time required is significantly longer than similar trips by automobile, as shown in Figure 3.15. The majority of transit trips require over 60 minutes to reach downtown.

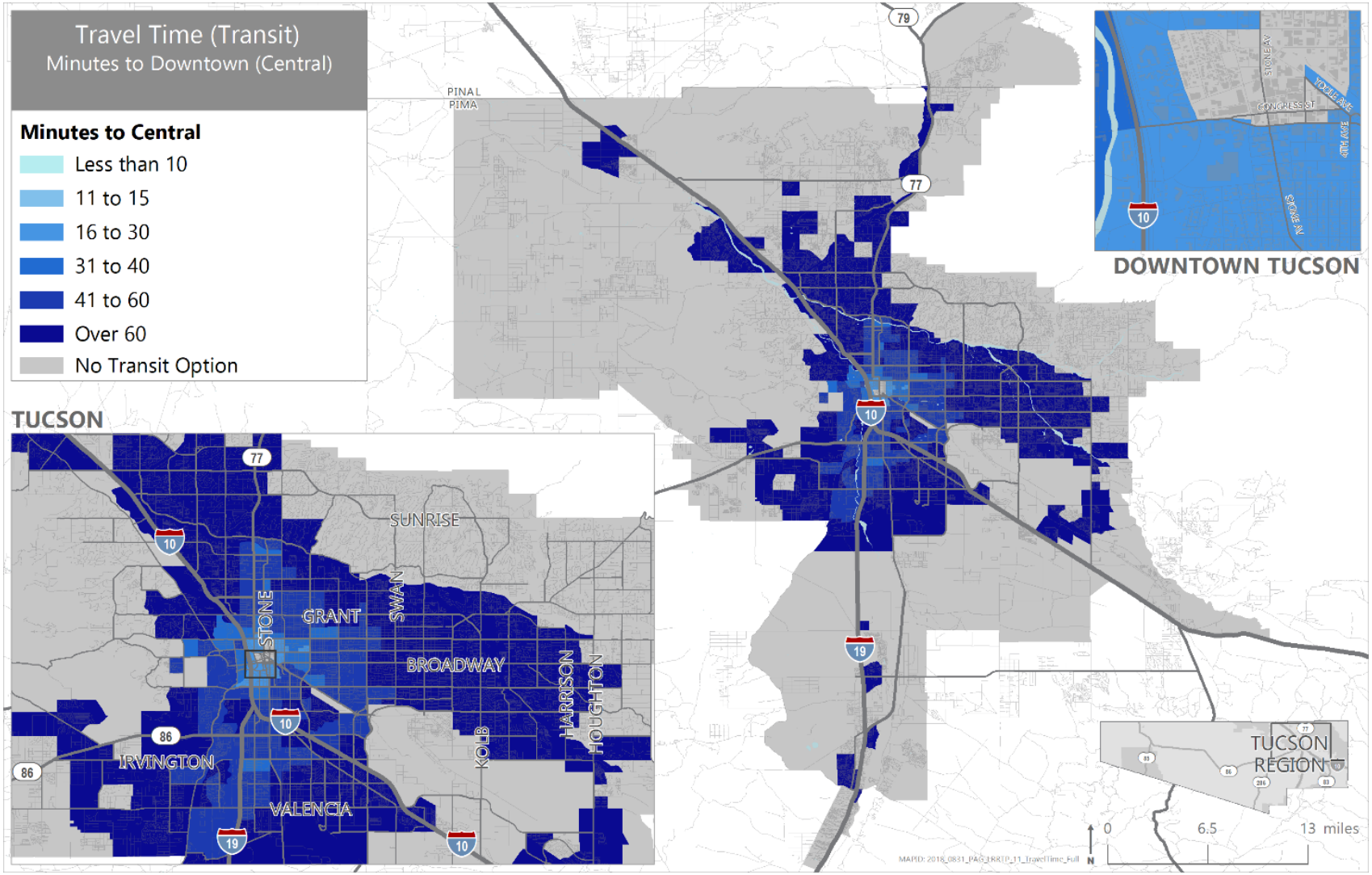
Figure 3.16 demonstrates the difference in travel time between transit and automobile to downtown Tucson. A large portion of the transit trips downtown are over 30 minutes longer than the comparable automobile trip. The comparison of trip time provides an insight into the general competitiveness of transit. The current competitive transit market for downtown trips is concentrated near downtown and the areas surrounding the Tucson Mall, South Tucson, the Roy Laos Transit Center, and along Speedway Boulevard to Alvernon Way.

Figure 3.14 Travel Time to Downtown Tucson by Automobile, 2017



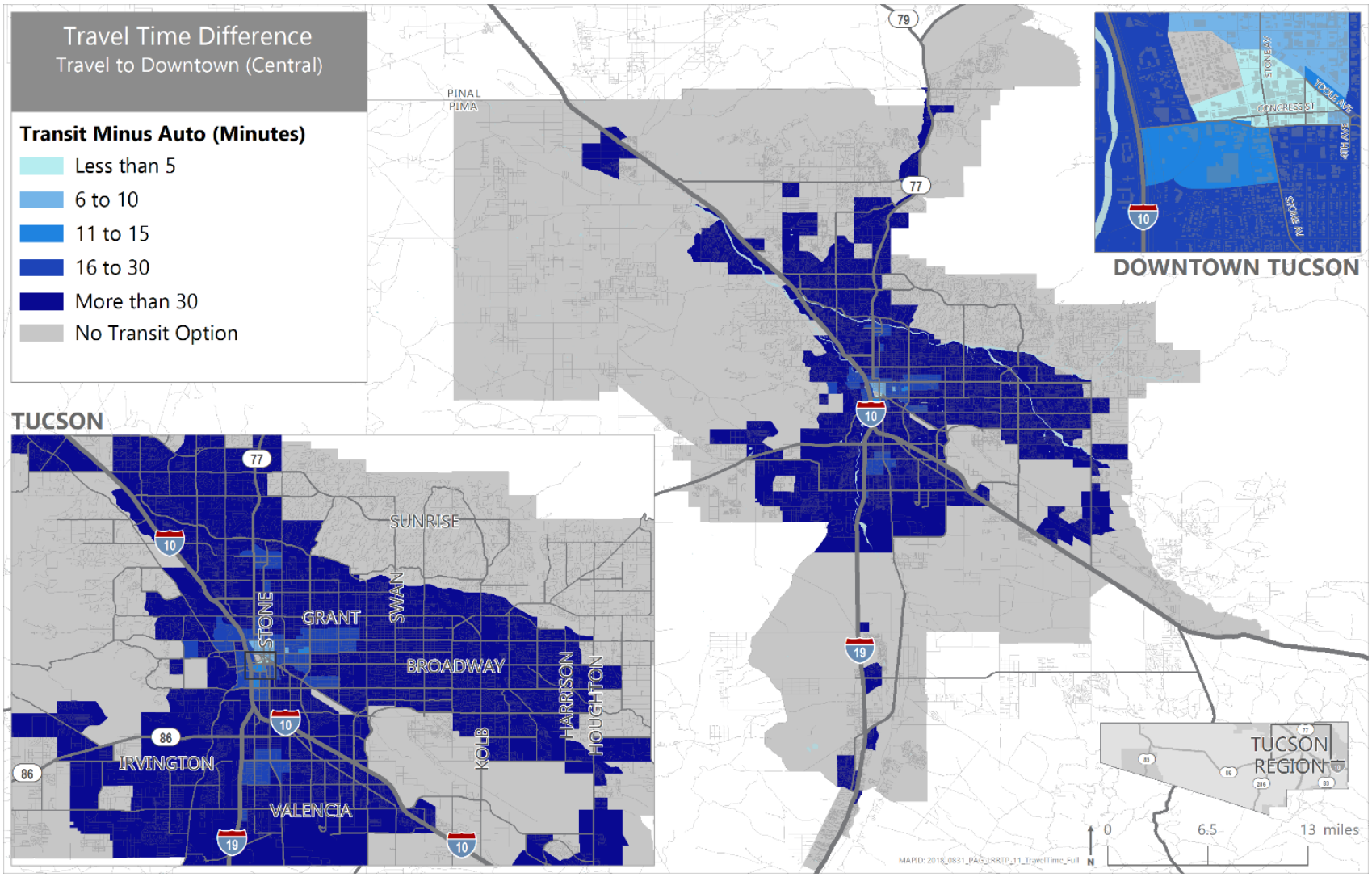
Source: Pima Association of Governments Travel Demand Model Data, 2017.

Figure 3.15 Travel Time to Downtown Tucson by Transit, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017.

Figure 3.16 Travel Time Comparison between Transit and Automobile, 2017



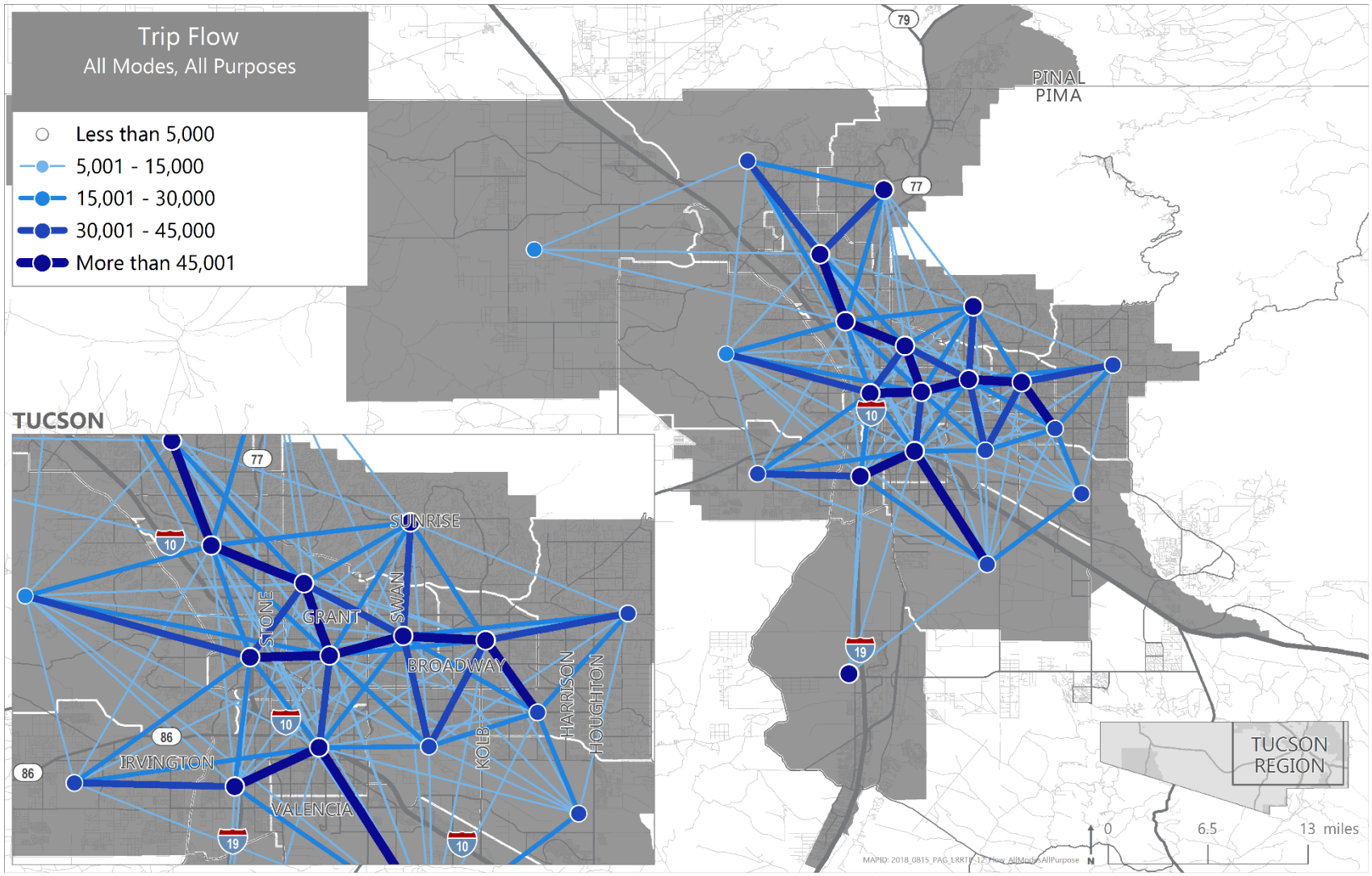
Source: Pima Association of Governments Travel Demand Model Data, 2017.

3.3 Trip Flow Patterns

To understand the travel across the region, this analysis uses trip flows between two subregions to determine the general patterns of demand. For example, a resident commuting to and from work between Flowing Wells and Central subregions is expressed as two trips along a line connecting the two subregions. A subregion's internal trips, or trips with both ends of the trip remaining within its boundaries, are represented as a centroid. Figure 3.17 depicts travel within and between the subregions for trips taken by all modes for all trip purposes. Trips between subregions of Central and University, University and Palo Verde, University and Campus Farm, Campus Farm and Flowing Wells, and Palo Verde and Northeast represent the heaviest flows between subregions. Palo Verde, Oro Valley / Catalina, Northeast and University subregions generate the greatest internal trip activity. Approximately 23 percent of all trips within the region occur between and within these subregions.

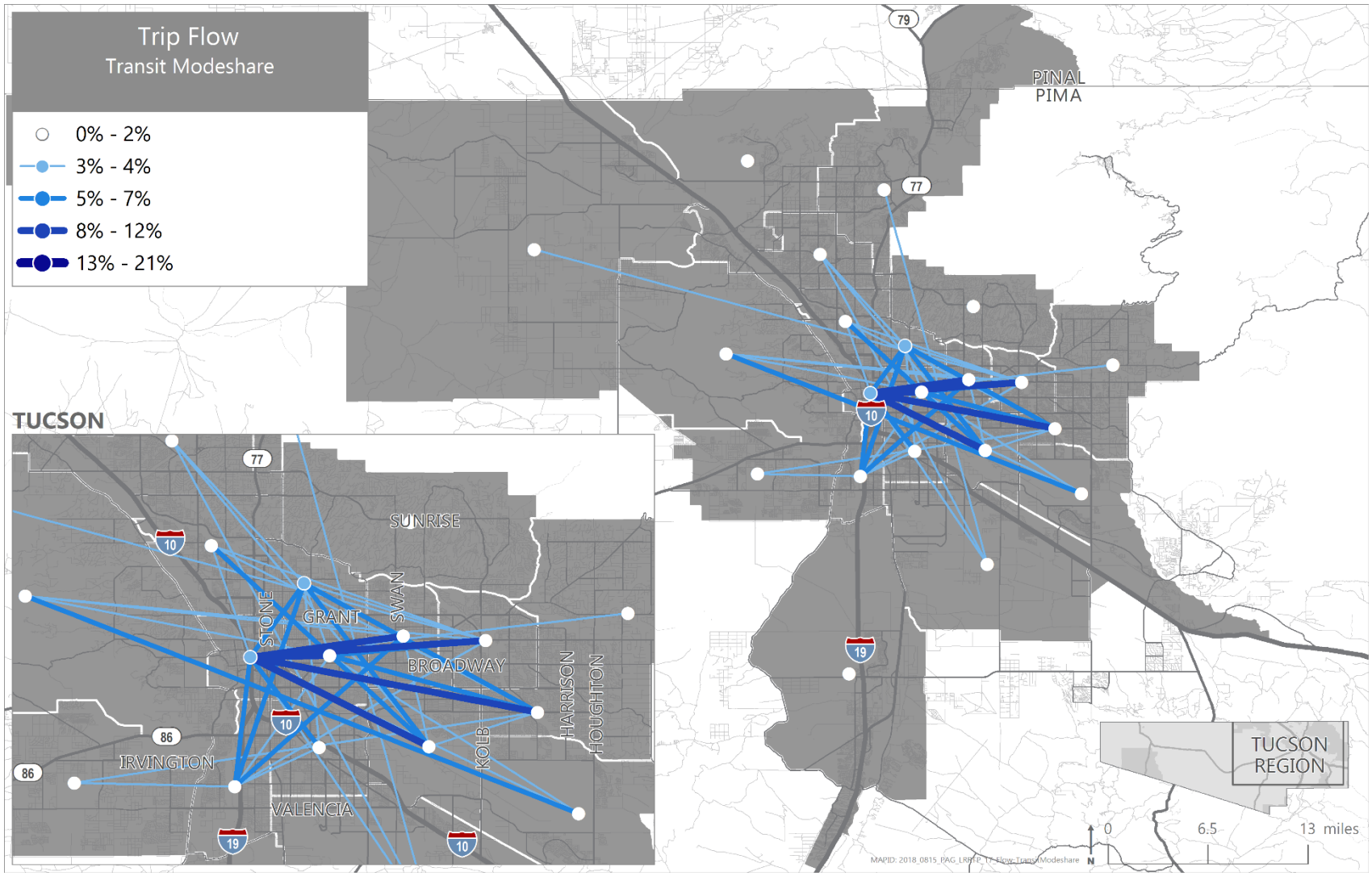
Exploring where residents travel when taking transit, a different pattern of trip demand emerges. As shown in Figure 3.18, the travel flows generating the largest share of transit usage (over seven percent) occurs between the Central subregion and the subregions of Campus Farm, University, South, Palo Verde, Northeast, South Harrison, and Davis-Monthan. The travel between Central and University subregions and Central and Campus Farm subregions represent both a relatively high mode share and a substantial regional travel market. Together, transit trips between Central and University and between Central and Campus Farm represent 13 percent of all transit trips.

Figure 3.17 Concentration of All Trips, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017. Sun Tran On-Board Transit Passenger Survey, June 2016.

Figure 3.18 Transit Mode Share, 2017



Source: Pima Association of Governments Travel Demand Model Data, 2017. Sun Tran On-Board Transit Passenger Survey, June 2016.

3.4 Trends and Conclusions

The travel patterns of the Tucson region provide several opportunities to increase the transit market share. Currently, only 1.5 percent of all trips are taken by transit throughout the region; however, between the travel markets of Central and University, Central and South, and between Central and Campus Farm subregions, over five percent of trips are taken on transit. The concentration of travel demand within and between a small number of subregions where transit service currently exists positions transit in an ideal situation to better compete with single-occupancy automobile travel. Figure 3.19 depicts **critical transportation markets and opportunities for increased transit market share.** Table 3.1 shows a breakdown of the existing bus routes serving these transportation markets.

Half of the trips originating in Flowing Wells, Campus Farm, Palo Verde, and Northeast subregions are short distance trips, between one and five miles. There is sufficient opportunity for transit to capture a larger share of the short trip distance travel demand in areas already served by the transit network.

When comparing transit travel time to other modes for short-distance travel, walk and wait times become a critical factor. Improvements to the total transit trip time will better position transit to compete with single occupancy travel. The majority of transit trips destined for the Central and University subregions are over twice as long as the comparable trip by automobile. Finally, the dispersed travel patterns between origins (trip production nodes) and destinations (trip attraction nodes) will continue to limit the potential for high volume transit markets. While some of these high volume markets exist now or will emerge in the future, evaluating their feasibility will require more detailed assessments of transit priority treatment along the routes, parking policies at destinations, and the built and pedestrian environments at both the origins and destinations. The detailed data underlying these trends will be available to inform service concepts developed in the next phase of this study.

Figure 3.19 Key Travel Markets

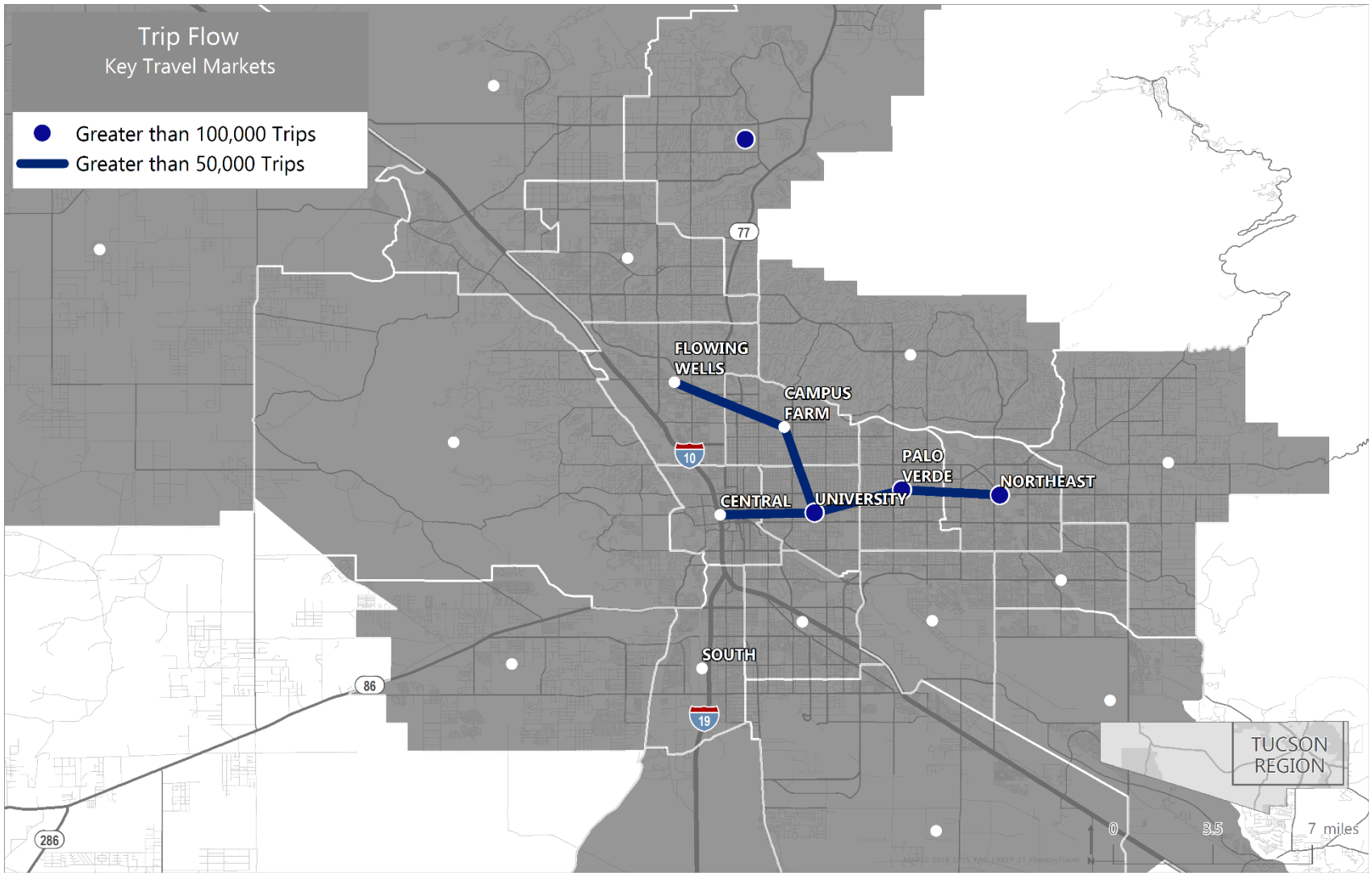


Table 3.1 Existing Bus Routes between Key Travel Markets

Route Name	Weekday Midday Frequency	Flowing Wells - Campus Farm	Campus Farm - University	Within University	Central - University	University - Palo Verde	Within Palo Verde	Palo Verde - Northeast	Within Northeast
1 - Glenn/Swan	30		■	■	■	■	■		
2 - Pueblo Gardens	30			■					
3 - 6th St/Wilmot	30			■	■	■	■	■	
4 - Speedway	15			■	■	■	■	■	■
5 - Pima/West Speedway	30			■	■	■	■	■	■
6 - Euclid/N 1st Ave	15		■	■					
7 - 22nd St	15			■	■	■	■	■	■
8 - Broadway	15			■	■	■	■	■	■
9 - Grant Road	15			■	■	■	■	■	■
10 - Flowing Wells	30	■							
11 - Alvernon Way	15		■	■					
15 - Campbell Ave	15		■	■					
16 - Oracle/Ina	15	■							
17 - Country Club/29th St	30	■	■	■					
25 - S Park Ave	30			■					
34 -Craycroft/Ft Lowell	15						■		
37 - Pantano	30								■
61 - La Cholla	30	■							
102X - Northwest-UA Express	Peak Only				■				
103X - Northwest-Downtown Express	Peak Only	■	■	■	■				
105X - Foothills-Downtown Express	Peak Only			■	■	■	■		
107X - Oro Valley-Downtown Express	Peak Only	■							
108X - Broadway-Downtown Express	Peak Only			■	■	■	■	■	■
109X - Catalina Hwy-Downtown Express	Peak Only			■	■	■	■	■	■
201X - Eastside-Aero Park Express	Peak Only							■	

4.0 Built Environment

The built environment has a significant influence on the functionality of service and widespread transit adoption. The decision to take transit (as opposed to driving alone) depends on several factors including total travel time, frequency, and reliability. In addition to these aspects of transit service, convenient and safe access is also a critical factor in whether or not travelers take transit. Land use, or the form and function of areas surrounding transit corridors, is another key determinant for whether transit is a competitive travel choice.

While many factors ultimately influence travel behavior, transit-supportive land uses, such as higher-density housing or job centers, play a key role in encouraging ridership. Compact transit-supportive land uses support places concentrated with amenities and activities. Areas that include a mix of commercial and civic needs and activity, like banks, grocery stores, and restaurants, increase the likelihood that residents and workers can accomplish their daily errands without the use of a personal vehicle. Increased activity at the street level supports great urban spaces with increased economic activity while ensuring sustained demand for public transit services.

Post-war development in Sun Belt cities like Tucson catered to automobile transportation, a practice reflected in land use patterns across the region. Though Tucson has a strong central grid, auto-centric subdivision design (especially for neighborhoods designed around single-family housing) can complicate the journey between origin and destination and hamper transit ridership. When the time spent walking to, waiting for, and transferring between buses exceeds the time spent moving towards one's destination, few people will elect to take transit.

Existing land use patterns can provide insights on how to identify new transit markets for areas which currently lack service. This analysis examines the existing use and planned development in the study area, as well as measures describing the region's urban form. These factors show how coalescent land use and transportation strategies may foster increased ridership, encourage transit-oriented development, and devise long-range investments which may serve areas anticipating more significant growth.

4.1 Population Density

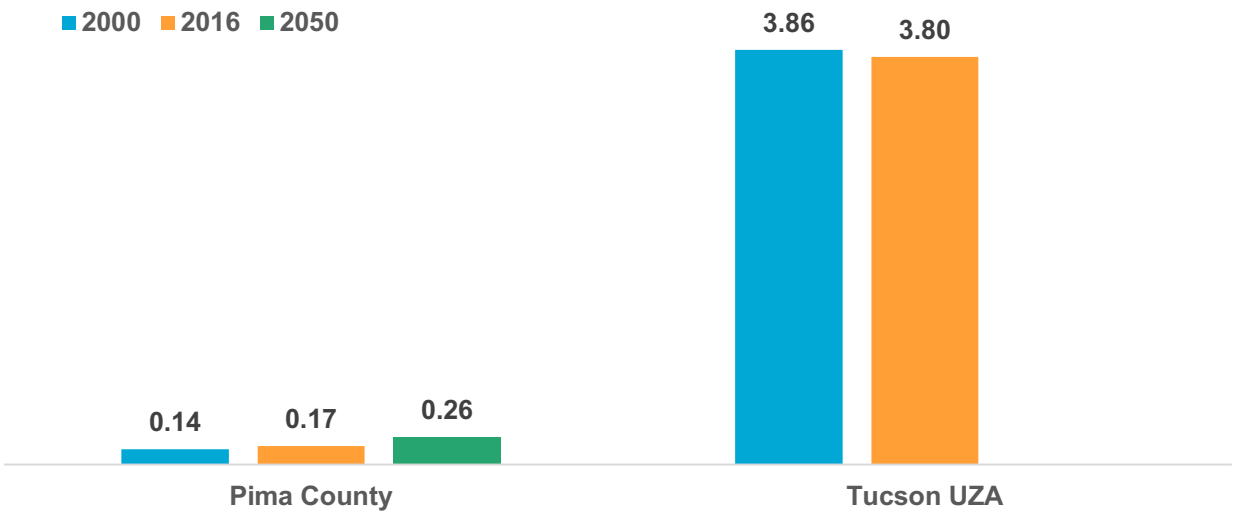
In 2016, Pima County's population density was 0.17 people per acre compared to Tucson UZA's population density of 3.80 people per acre. As a result of the UZA boundary expanding to capture low dense areas in 2010, the overall density of the Tucson UZA decreased slightly. If population projections hold, Pima County's anticipated population density in 2050 would increase to 0.26 people per acre, as depicted in Table 4.1 and Figure 4.1.

Table 4.1 Population Density

	2000		2016	
	Pima County	**Tucson UZA**	**Pima County**	**Tucson UZA**
Population	843,732	720,425	1,016,373	859,160
Acres	5,880,036	186,468	5,880,036	226,214
Density (per Acre)	0.14	3.86	0.17	3.80

Source: U.S. Census, American Community Survey, and IPUMS-USA.

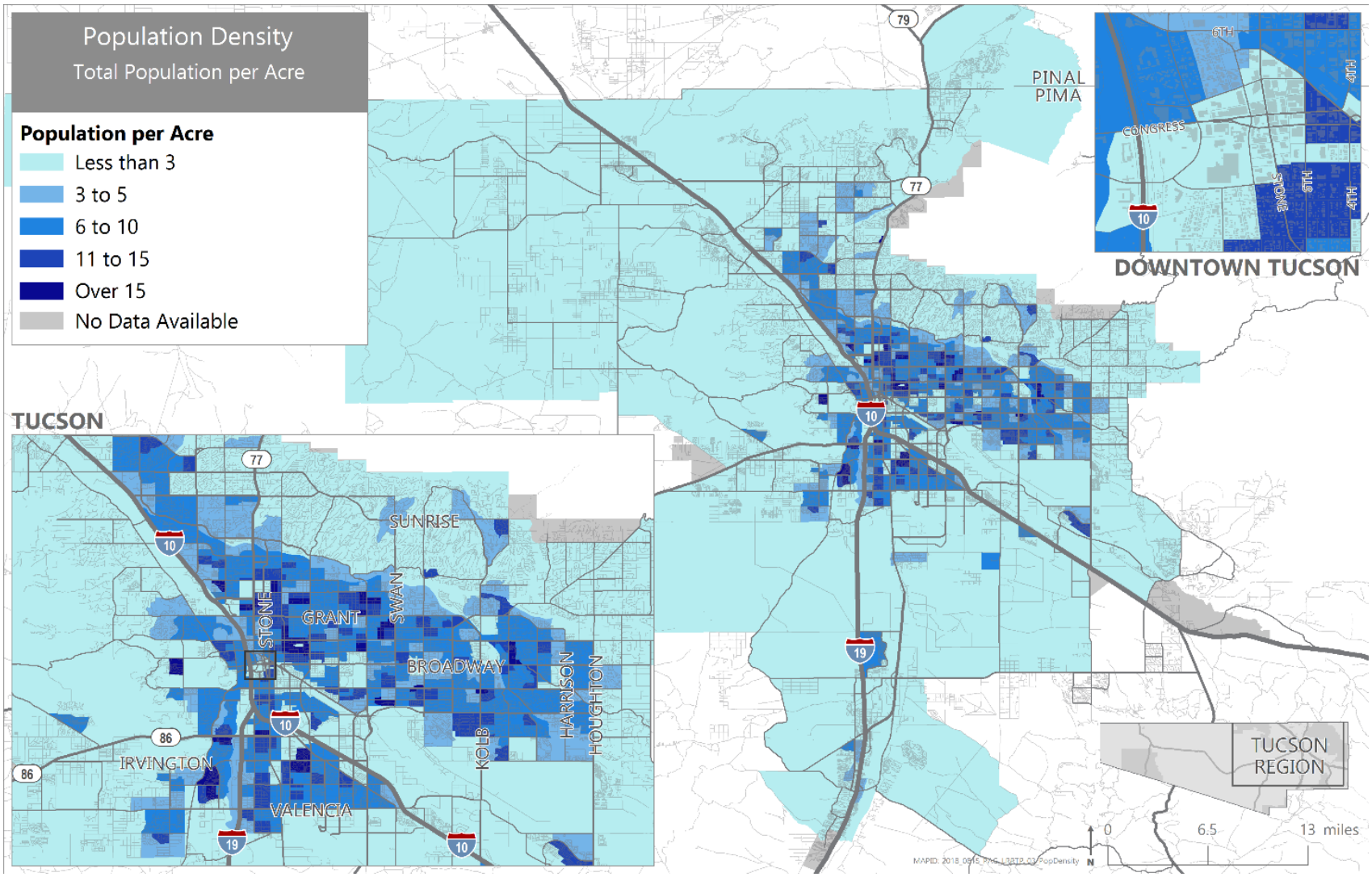
Figure 4.1 Population Density by Year (Persons per Acre)



Source: U.S. Census, American Community Survey, and IPUMS-USA.

Density within the Tucson UZA is concentrated within city limits of Tucson, particularly around downtown, north of the Tucson International Airport, the University of Arizona, and from downtown Tucson east to the Rincon Mountains (Figure 4.1). A few key neighborhoods have residential densities above 20 residents per acre, indicating support for transit services, including Amphi, Feldman's, North University, West University, Oak Flower, Dodge Flower, Carriage Park, Dietz, Terra Del Sol, and Cherry Avenue. Together with the University of Arizona, these neighborhoods represent about seven percent of the total study area population. These neighborhoods also support some of the region's major employers, including the Tucson Mall (near Amphi), the University of Arizona and the Tucson Campus of the Bahner University Medical Center (near Feldman's, North University and West University neighborhoods), the Tucson Medical Center (near Oak Flower and Dodge Flower neighborhoods), Research Loop employment center (near Dietz and Terra De Sol neighborhoods), and the Tucson International Airport and Southern Arizona Veterans Administration Health Care System (near the Cherry Avenue neighborhood).

Figure 4.2 Population Density

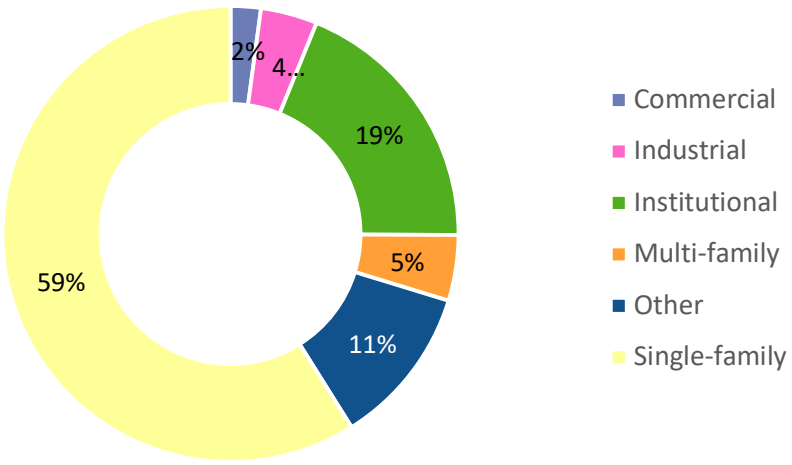


Source: 2016 American Community Survey, 5-Year Estimate.

4.2 Existing Study Area Land Use

Today, single-family homes account for more than half of Tucson's existing landscape, contributing to low densities across the study area overall. Commercial land use represents the second most dominant zoning type, with smaller proportions of multi-family, industrial, and institutional uses also scattered throughout the study area. Figure 4.3 shows the overall breakdown of zoning types within the study area.

Figure 4.3 Share of Existing Zoning

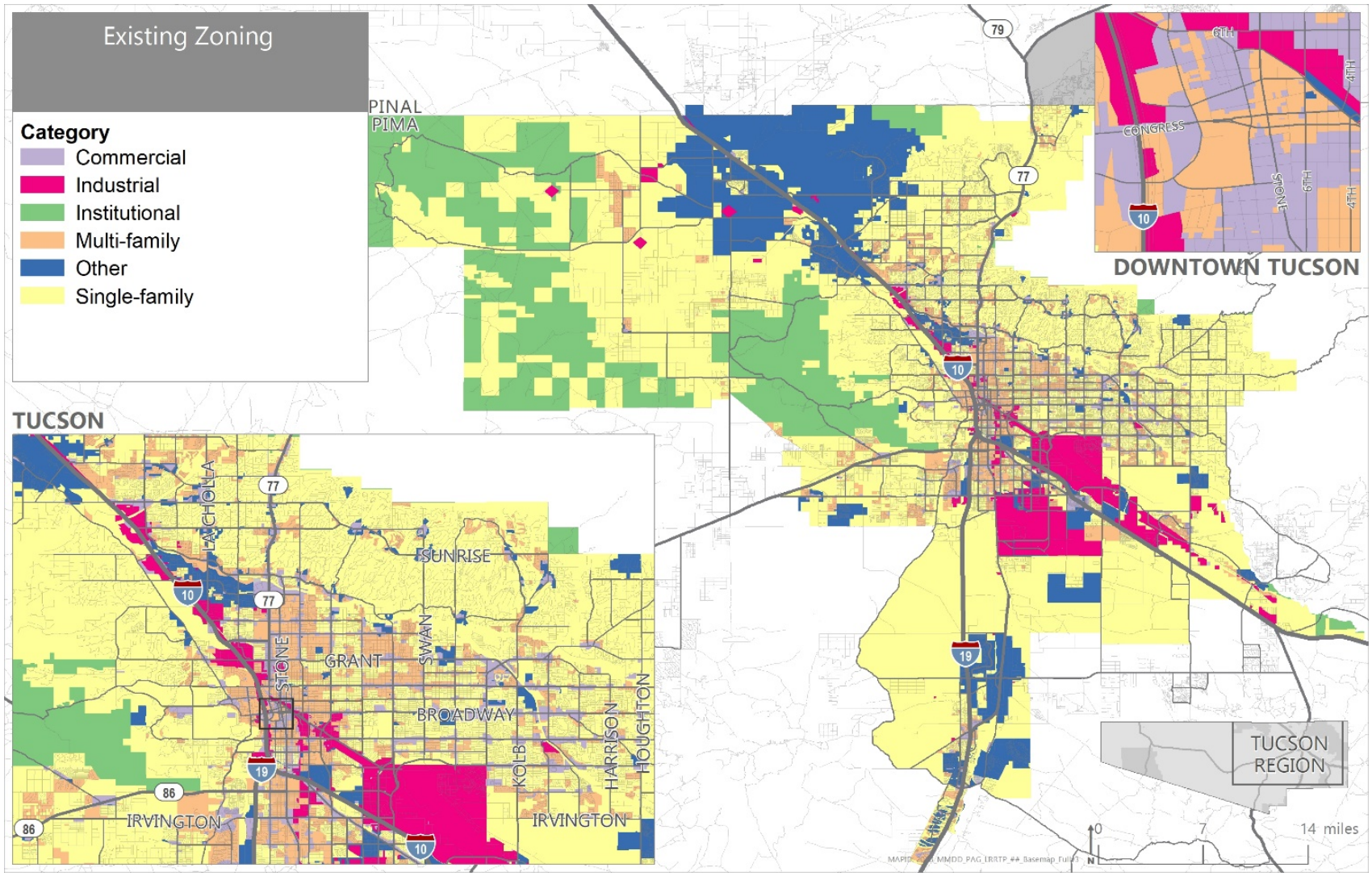


Source: Pima Association of Governments, 2018.

The existing zoning map displays the locations of these zoning types within the study area (Figure 4.4). Single-family zoning exists throughout the study area, with most residential land use located outside of the downtown core. Most multi-family zoning is concentrated north and south of downtown, or along key arterials currently or feasibly served by transit. These include areas north of downtown (near AZ-77), and south of downtown (near I-19). Additionally, several Planned Area Developments (PAD) downtown are also categorized as multi-family, though several of these PADs also contain commercial uses. Industrial zoning is clustered around Tucson's interstates, including I-10 and I-19, mostly southeast of downtown, and north and south of I-10. The majority of Tucson's institutional zoning is on military bases, such as Davis-Monathan Air Force Base. These areas are less transit-friendly than traditional institutional land use, such as courts or hospitals.

Commercial zoning also surrounds Pima County's interstate highways. Most commercial development is located north of I-10, between Davis-Monthan Air Force Base and Kino Parkway. Commercial land use is also found around the Tucson International Airport, as well as along major arterials protruding from downtown Tucson's central grid. Institutional land use was developed for the Arizona State Prison, schools, and the Pima Mine Road Recharge Project, and also includes major parklands on the study area's western extent. The southern portion of the study area, between I-19 and I-10, contains vacant and agricultural land and represents the study area's least densely populated area.

Figure 4.4 Existing Zoning



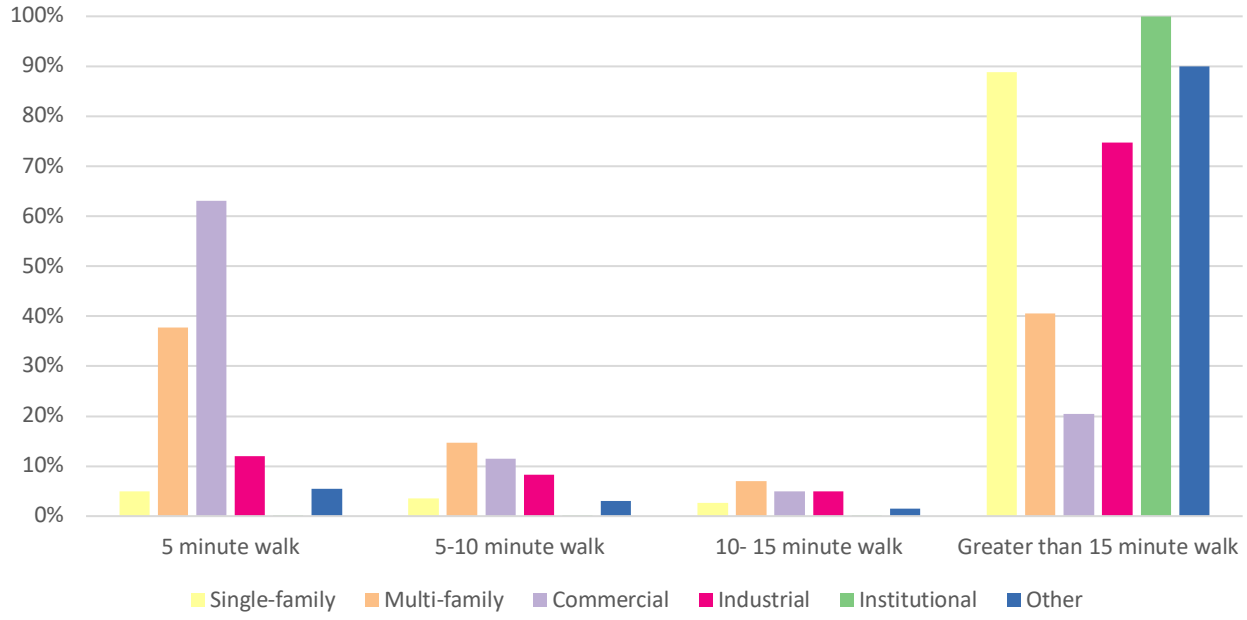
Source: Pima Association of Governments, 2018.

4.3 Existing Land Use Near Transit

Existing land use near transit service can have strong impacts on ridership. Areas with a highly connected street network and dense land uses are more likely to support transit, due to the higher concentration of nearby passengers who can walk to a stop or station. **Transit supportive land use, such as multi-family housing and dense employment centers, places more people closer to transit, increasing the number of potential passengers.**

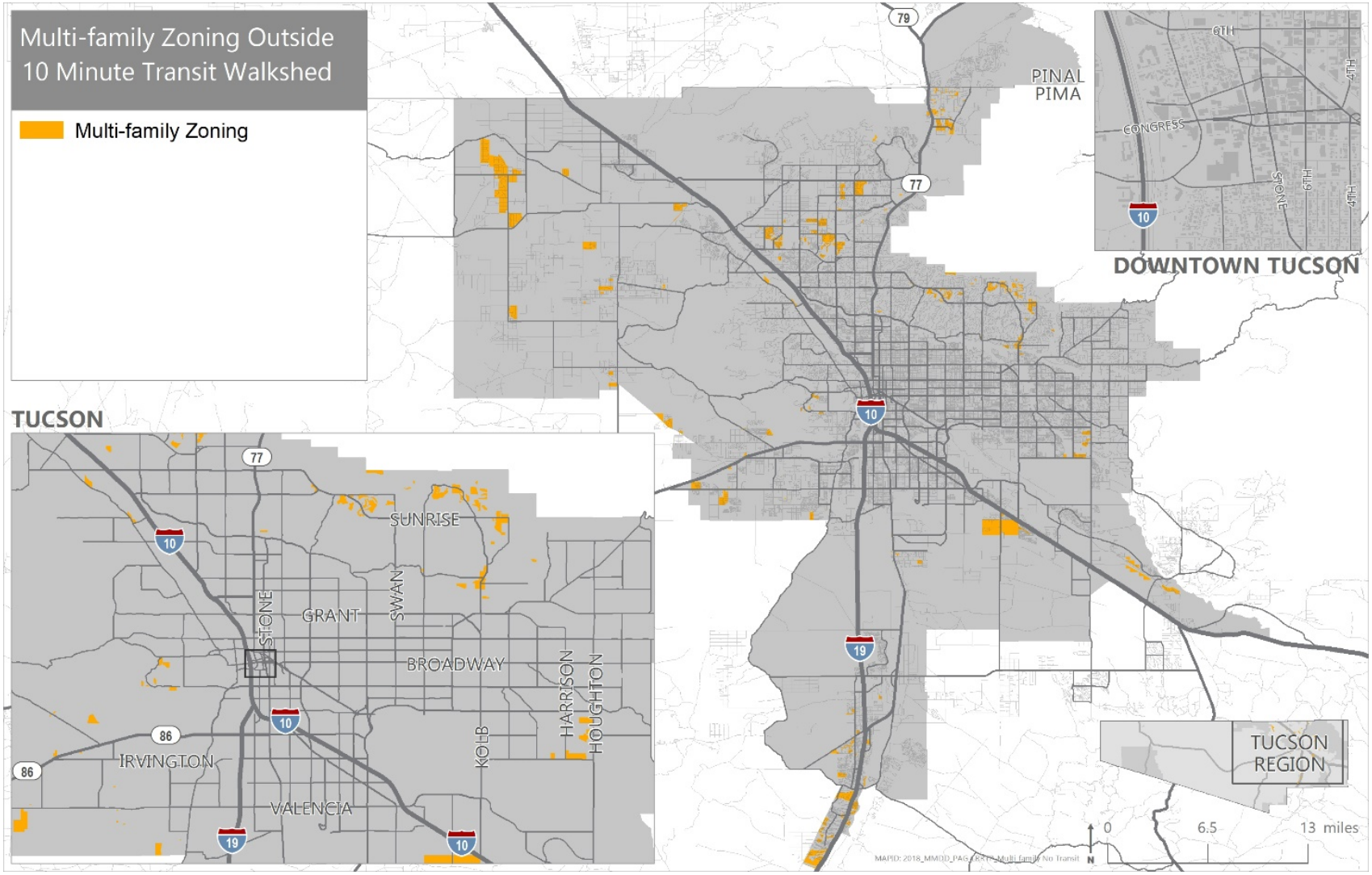
Figure 4.5 below depicts the share of each zoning category within a 5-, 10-, 15-, or greater than 15-minute walk to a transit stop within the study area. Although the overall share of the study area's single-family residential zoning is below 11 percent within a 15-minute walk to a transit stop, these respective walksheds largely encompass single family homes (almost half). The high proportion of multi-family zoning (compared to the overall share across the study area) suggests that much of Tucson's multi-family housing is currently served by transit. Currently, 48 percent of Pima County's existing multi-family zoning land area is located outside of a 10-minute walk from transit. Figure 4.6 shows the location of these areas, largely within the county's suburban fringe.

Figure 4.5 Percentage of Study Area Zoning within a 5-, 10-, 15- and Greater than 15-Minute Walk to a Transit Stop



Source: Pima Association of Governments, 2018.

Figure 4.6 Multi-Family Zoning Outside 10-Minute Transit Walkshed

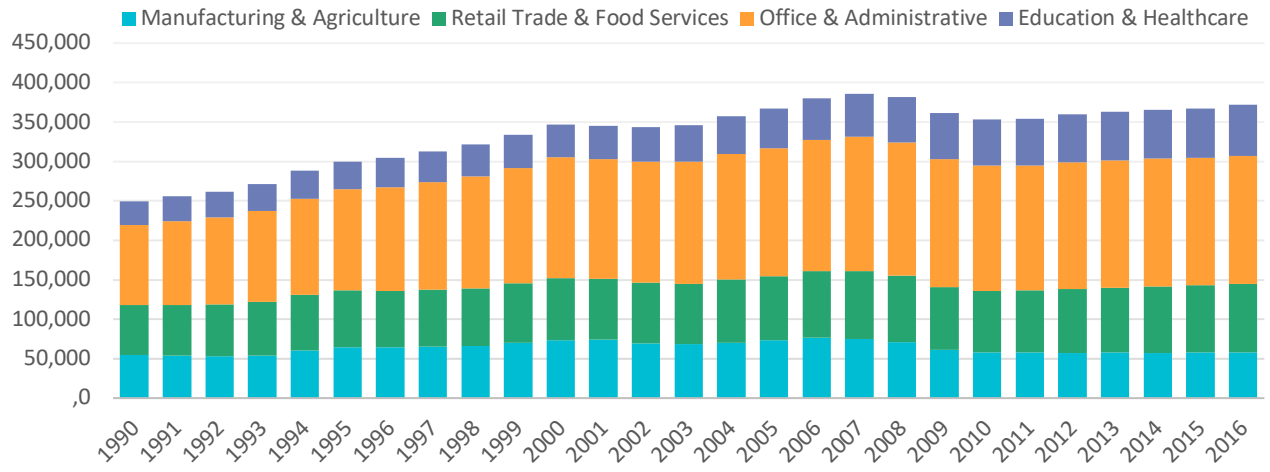


Source: Pima Association of Governments, 2018.

4.4 Employment

Employment within Pima County is concentrated in the Tucson UZA. As shown in Figure 4.7, over 67 percent of all jobs in Pima County are in the office and administrative and retail transit and food service sectors. Pima County's employment growth has—with a few exceptions—grown steadily since 1990. The compound annual growth rate for Pima County is 1.5 percent since 1990. However, there are significant differences between employment sectors. Job growth in the manufacturing and agriculture sector has remained relatively flat at 0.2 percent, while the number of jobs in education and healthcare has grown at 2.9 percent.

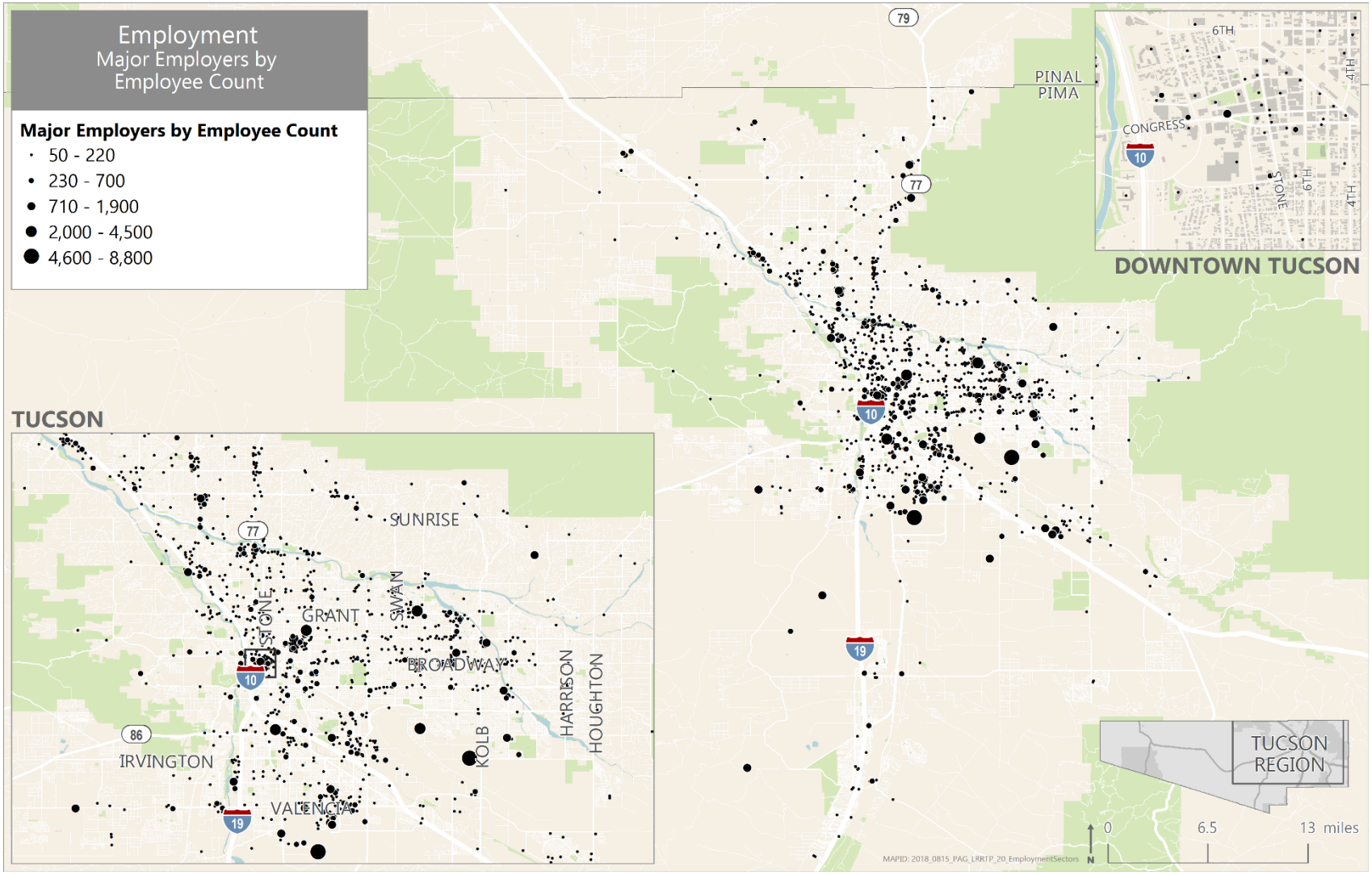
Figure 4.7 Pima County Employment Growth by Industry Sector



Source: Arizona Labor Statistics, Current Employment Statistics Data.

Figure 4.7 depicts major employers within the Tucson region. Major employers are dispersed across the region, but concentrated along and near major transportation facilities, like highways, major roadways, and airports.

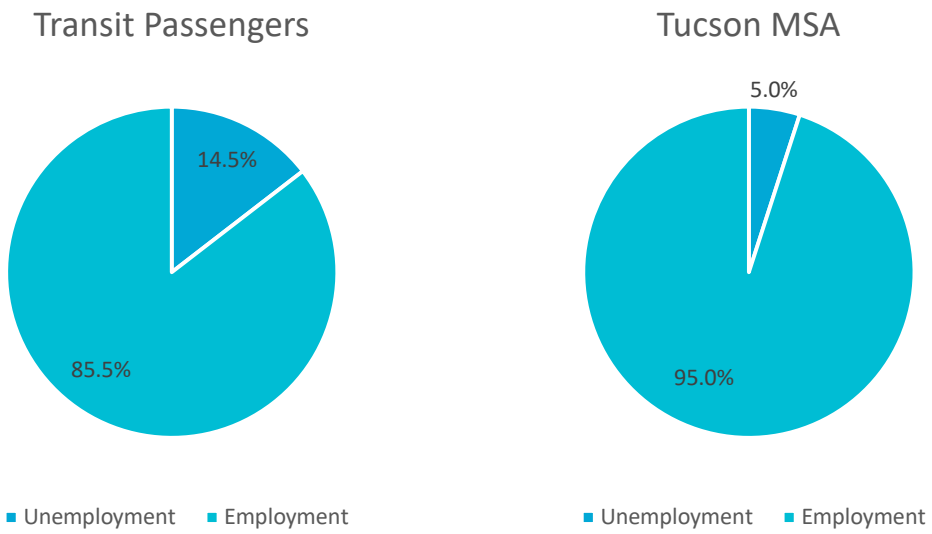
Figure 4.8 Major Employers by Employee Count



Source: Pima Association of Governments.

According to the 2016 Sun Tran On-Board Transit Passenger Survey, 63 percent of existing transit passengers are employed, either full-time or part-time. Of the existing transit passengers in the labor force, those who are employed or jobless but seeking employment and available for work, over 14 percent are unemployed. The unemployment rate of existing transit passengers is about three times higher than the unemployment rate of the Tucson MSA, as shown in Figure 4.9.

Figure 4.9 Employment Status of Existing Transit Passengers in the Labor Force



Source: Sun Tran On-Board Transit Passenger Survey, June 2016, Arizona Unemployment Statistics Program, Seasonally Adjusted Statistics Report, June 2016.

4.5 Parking

Parking strongly influences whether people will decide to take transit, while also shaping urban form. Factors like supply (e.g. whether one can expect to find a parking spot near a destination) and cost (e.g. whether that spot is available at a fair price) influence whether transit is a preferable alternative to driving. At present, the perceived convenience of cheap, available parking makes driving a default choice for most. The unquestioned ease of this decision ultimately increases congestion, especially in areas like downtown Tucson or near the University of Arizona, where drivers may repeatedly circle surrounding blocks to find a suitable spot.

Density drives transit ridership, placing more people closer to stops and stations, decreasing distances between transit and one's ultimate destination. Yet, excessive parking supply dilutes the benefits of that density. At present, parking options in downtown Tucson and near the Sun Link corridor are abundant and affordable, with more than 3,000 covered spaces in parking garages, almost 1,000 spaces in surface lots, more than 1,000 on-street metered spaces in downtown Tucson, and nearly 500 additional spaces in adjacent business districts. These parking facilities also create a less pedestrian-friendly environment, restricting activity and amenities in ostensibly walkable areas. Walking past large, largely empty lots is a safety concern for many transit passengers, especially women and adolescents.

By adjusting the existing parking supply transit ridership can be encouraged and the value of land otherwise devoted to parking can be maximized. Examples of such regulations may include minimizing residential

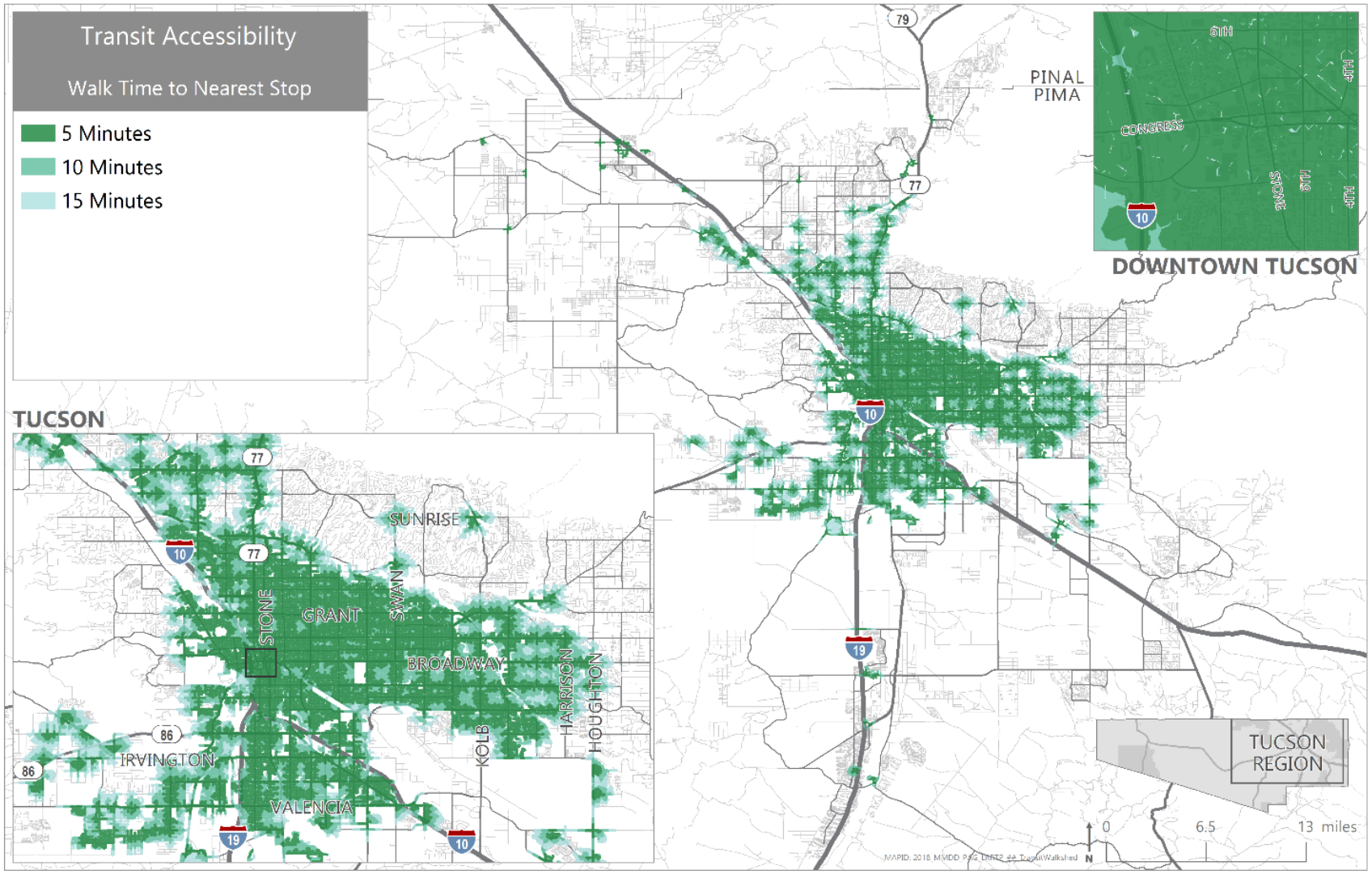
parking requirements near frequent transit service, restricting times for existing spaces, and dynamic pricing, in which costs increase during peak hours and special events. Such strategies require coordination with several entities, ranging from municipal zoning authorities to private employers. One key player is Park Tucson, which manages on-street and off-street parking Downtown, around the University of Arizona and near the Sun Link line. Park Tucson's concurrent parking study for Downtown will identify how the City of Tucson can improve utilization of its existing parking supply, including an analysis of current demand and activity. Partnerships with major employers and institutions also play an important role in promoting transit by managing parking demand. For example, the University of Arizona offers students a 50 percent discount for all transit passes, and simultaneously charges up to six times that cost for an annual parking pass.

4.6 Urban Form

Urban form also strongly influences whether people elect to take transit. Access to transit stops and stations is affected by the quality of surrounding infrastructure (e.g., whether streetlights illuminate a sidewalk) and broader design patterns (e.g., the size of street blocks near transit). Comfort and convenience are both important in shaping a pedestrian's journey to transit.

The quality of pedestrian access is determined by the presence and quality of sidewalks, safe street crossings, and the distance required to walk to access transit. The City of Tucson maintains a Design Guidelines Manual, created in 1999, which offers standards for pedestrian and alternative transportation modes for residential, office/commercial, and large retail/commercial districts. Additionally, special standards exist for Pedestrian Districts and Transportation Corridors/Nodes. These guidelines highlight the principles of transit-supportive street design, but ongoing revisions are needed to reflect today's planning and development climate. Figure 4.10 shows where pedestrians are able to walk to a transit facility within 5, 10 and 15 minutes.

Figure 4.10 Transit Accessibility by Walking

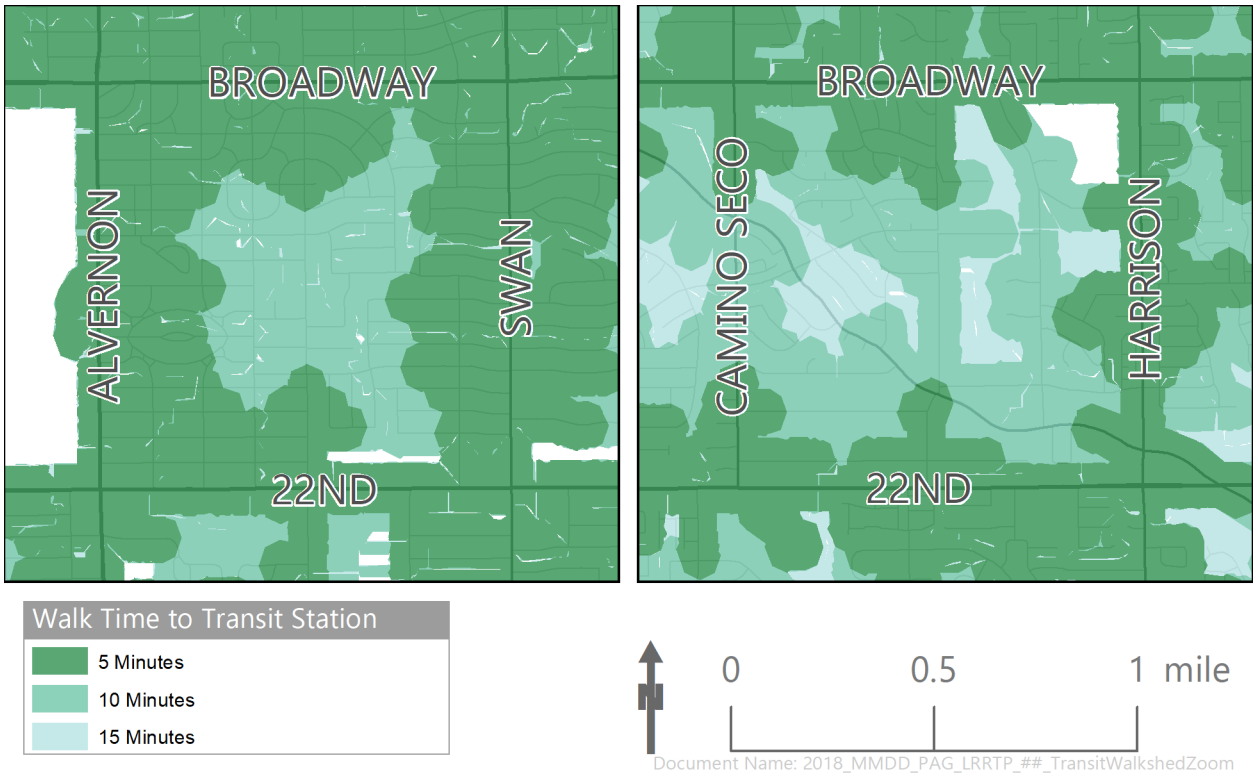


Source: Pima County.

While Tucson's downtown and central neighborhoods are highly walkable, far fewer areas are pedestrian-friendly in the study area's margins. Figure 4.11 shows how transit access varies based on the layout of the street grid. Within areas with a highly-connected street grid, transit stops are located within a five- to ten-minute walk of most households. In areas with a less-connected street grid, such as neighborhoods to the east, fewer households are located within a short walk of transit stations.

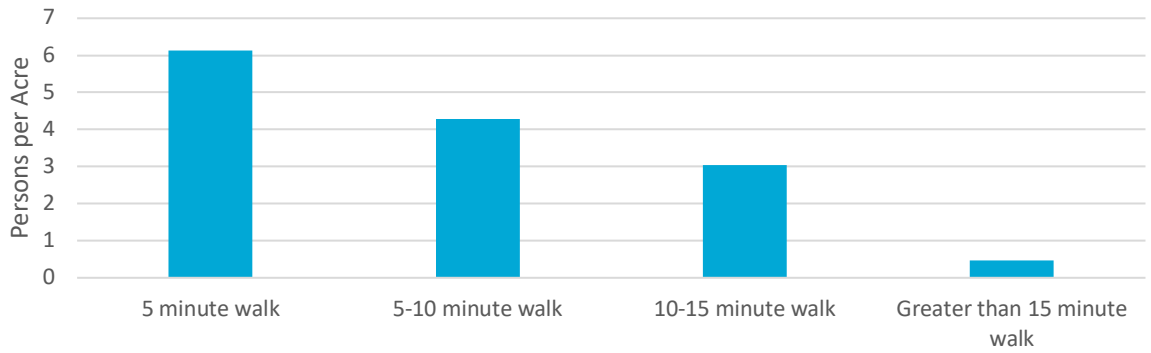
Over half of the population lives within a 10-minute walk to transit. The areas with access to transit within a 5-minute walk have a higher population density than areas requiring a longer walk (Figure 4.12).

Figure 4.11 Transit Access by Walk Time



Source: Pima County.

Figure 4.12 Population Density by Walk Time to a Transit Stop



Source: 2016 American Community Survey, 5-Year Estimate.

4.7 Future Development Focus Areas

As described in Section 2, Pima County continues to experience modest growth across the study area. **Much of this growth is taking place in areas near existing transit service, or areas which could feasibly be served by new transit service. In particular, growing demand near the city's core and transit corridors will influence the recommended transit service and future investments.**

Recent infill development downtown has been strongly tied to Tucson's Sun Link streetcar project. Land use planning between the City of Tucson, the Pima Association of Governments, and the Regional Transportation Authority also seeks to maximize the value of Tucson's Sun Link streetcar project. The Sun Link line connects the University of Arizona, the 4th Avenue Business District, the Mercado development, and downtown. Opened in 2014, the streetcar corridor has already seen more than $800 million in transit-supportive development, including 50 new restaurants, approximately 1,500 new student housing units, and 58 new retail businesses within the first two years of streetcar operations. These development opportunities were supported through the Streetcar Land Use Planning process, which identified areas for appropriate, high-quality investment in and around the streetcar corridor.

According to the City of Tucson, as of 2016, the streetcar corridor maintains more than 3,000 housing units, over 250,000 square feet of retail, over 2,200,000 square feet of office space, and over 1,400,000 square feet of other commercial space. Nevertheless, additional residential and employment density may be needed to increase transit ridership in this area. For example, the Mercado development features smaller lot sizes than Tucson overall, yet still only features 7.7 dwelling units per acre for its first phase of development. Parking minimums also mandate one space per unit, detracting from the total space potentially devoted to residential or commercial uses in this development.

Future planned development also includes the revitalization of Tucson's historic Miracle Mile and Oracle neighborhood, located about four miles north of downtown. This gateway catered to early automobile enthusiasts, a legacy reflected in the corridor's rich historic commercial and housing stock. Now an opportunity to preserve (and activate) these properties, revitalization around Stone Avenue and the Miracle Mile corridor will continue to foster development near downtown Tucson. This connected commercial activity will encourage an expanded transit market in Central Tucson.

Pima County is readying itself for future transit-supportive growth through its recent comprehensive plan effort, *Pima Prospers*. Completed in 2015, this plan identified multiple focused development investment areas, including each of the incorporated jurisdictions of the County, the Tucson International Airport-I-10 economic development corridor, unincorporated Southwest Tucson, identified Community Development Target areas and Revitalization Corridors, and the "Chuck Huckelberry Loop recreational trail.

4.8 Trends and Conclusions

While Tucson (and Pima County in general) is characterized by low-density land use, the area's cohesive, compact street grid provides an opportunity for linear, transit-supportive development. Currently, multi-family and commercial uses are located along major corridors near downtown. This concentration of housing and businesses provides a number of destinations where existing or new transit service could represent a competitive travel choice. Nonetheless, the dominance of single-family zoning, especially in the study area's outlying communities, creates challenges for competitive transit service due to the limited concentration of activity, and therefore demand, at the street level.

Overall, levels of pedestrian access remain constrained by these low-density land use patterns. Walkability is much stronger in Tucson's central neighborhoods, given the higher density of streets and intersections in these areas and more sidewalk infrastructure. The street network beyond these neighborhoods, however, more closely resembles suburban design patterns, with characteristics like curvilinear streets and cul-de-sacs which ultimately lengthen the journey from destination to a transit stop. Additionally, Tucson's deficient sidewalk network will need to improve in tandem with land use densification and pedestrian connectedness and other ameliorations to the city's urban form.

5.0 Conclusions

The declines in transit ridership since 2009 may be explained by a combination of local shocks (the 2015 bus strike and fare increases) and national market forces (e.g., increasing household car ownership, cheap gas, and reduced immigration).[26] These local and national drags are likely to change in the future. Nevertheless, the Tucson region will likely sustain current market conditions for its built environment and travel patterns that will present significant challenges for long range growth in public transit ridership. These include flat or modest growth in land use density, sprawling development pattern, cheap and abundant parking, and dispersed travel patterns. Understanding the magnitude and locations of these market conditions must be the first step in the development of an effective long range regional transit plan.

Of equal importance is an understanding of the potential market forces PAG and City agencies can harness to grow transit ridership. These include the opportunity for the City to channel new residential and commercial development into higher density nodes, improve the pedestrian environment, regulate parking, and improve transit priority treatments on the regional roadway network. These conditions are fundamental to creating a more competitive market for transit, which must be present for any public transit system to succeed, no matter how good the service.

Nevertheless, more recent research has studied the changing travel behaviors of Millennials as they age. [27, 28]While their inner-city lifestyles have shown significantly lower car ownership, fewer vehicle miles of travel, and higher transit ridership, some trends are emerging showing their behavior may be more of a lag compared to the earlier generation (Gen X), but not necessarily a permanent change. In some metropolitan areas, older Millennials are forming families and buying homes in more affordable suburbs where their travel patterns involve more intermediate stops (e.g., daycare, schools, spouse drop-offs, shopping after work, etc.). When transit is less accessible, these Millennials stop using transit. Retaining transit-intensive households in the transit-oriented communities requires more than providing quality transit. For a Millennial especially, they value school quality; nearby shopping and entertainment; safe neighborhoods; well-maintained public amenities (e.g., parks, museums, libraries, etc.).[29]

These same conditions and trends present the Tucson region with some potential opportunities for expanding high-frequency transit service if it can leverage and manage the market conditions that drive transit ridership. These opportunities occur as the region's population grows and generates more jobs. Accordingly, housing and transportation maybe organized to accommodate new residents with their evolving lifestyles and travel patterns.

In parallel, Tucson will sustain population cohorts who will continue to regard public transit as essential: i. e., students, young people, those without access to a vehicle, low-income households, and aging individuals, within the city limits of Tucson as residents continue to fill neighborhoods near downtown and the University

[26] https://www.scag.ca.gov/Documents/ITS_SCAG_Transit_Ridership.pdf

[27] Transit Center, *In Portland, Economic Displacement May Be A Driver of Transit Ridership Loss*, November 14, 2017. https://transitcenter.org/2017/11/14/in-portland-economic-displacement-may-be-a-driver-of-transit-ridership-loss/

[28] Venu M. Garikapati, Ram M. Pendyala, Eric A. Morris, Patricia L. Mokhtarian & Noreen McDonald (2016) Activity patterns, time use, and travel of millennials: a generation in transition?, Transport Reviews, 36:5, 558-584, DOI: 10.1080/01441647.2016.1197337

[29] Choosing Where We Live: Attracting Residents to Transit-Oriented Neighborhoods in the San Francisco Bay Area A Briefing Book for City Planners and Managers May 2010 Metropolitan Transportation Commission, https://mtc.ca.gov/sites/default/files/Briefing_Book-Choosing_Where_We_Live.pdf

of Arizona and more households solely rely on public transportation for mobility in and around the city. A range of mobility options will also continue to play an important role as Tucson continues growing older and the younger generations become a greater share of the overall population. As Tucson's population continues to age, and more of the population chose to be less dependent on personal automobiles, other transportation options will be imperative to maintain mobility in the region.

Specific trip types provide an opportunity to increase the market share for transit. **Short, off-peak trips characterize most travel in the region and should be prioritized by the transit system. Focusing on improvements to travel times, such as improving the walk and wait times for short distance trips, will provide an opportunity to capture a greater share of the overall travel. The concentrated east-west travel patterns connecting downtown Tucson, the University of Arizona and the other northeastern neighborhoods provide an opportunity for transit to capture a larger share of the overall transportation demand.**

Transit-supportive development can be supported by the compact street grid and proactive land use coordination. The concentration of major employers, multi-family and commercial uses around major corridors near downtown supports intensifying land use to create transit-accessible destinations. A focus on walkability and the prioritization of sidewalks, curb ramps and crosswalks will continue to improve the urban form and transit readiness.

Today, transit is relatively competitive in the central core of Tucson around downtown Tucson and the University of Arizona. With successful planning, coordination, and network design, transit can significantly improve its competitiveness with automobile trips and maintain viable transportation choices for residents. This market analysis highlights the demand side of the potential transit market. Service concepts, to be developed in a subsequent task of this study, will focus on the supply and will aim to match the travel markets demand identified in this analysis. The key target markets characteristics signifying a potential driver of transit utilization include the following:

- Aging residents in north and east Tucson;
- Millennial populations in downtown Tucson, northwest Tucson, and surrounding the University of Arizona;
- Households with no or low access to vehicles in the neighborhoods around downtown, northwest Tucson, near the University of Arizona, and east Tucson;
- Short distance (1-5 miles) non-commute travel between the University of Arizona and the surrounding neighborhoods; and
- Both peak and off-peak commute trips connecting major employers to nearby neighborhoods between downtown Tucson and east Tucson, between the University of Arizona and northeast Tucson, and between the University of Arizona and northwest Tucson.