



**Sustainable Infrastructure and South Mountain Village:
Land Use and Transit Oriented Development**

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Abstract

This project explores the current building and land use within the South Mountain Village (SMV) area. The South Central Light Rail extension corridor serves as a focus area, including a half mile radius around each of the five proposed light rail stations. Research of the area included analyzing SMV demographic information, analyzing land use and zoning, conducting a site visit, researching case studies, and information on current City of Phoenix, and other transit oriented development plans. Based on the research and case studies, recommendations and propositions are made for the 1) The implementation of a community-based transit oriented development 2) The integration of green infrastructure and urban agriculture, and 3) Best Land management practices and 4) policy to ensure appropriate and sustainable planning for the future.

Introduction

Problem

This project focuses on the Building and Land Use portion of the South Mountain Village (SMV) following the South Central Light Rail Extension corridor, South of the Rio Salado down to Southern Ave. The half mile radii around the proposed Light Rail Stops is the area being considered.

The project scope aims to address public transit development and connectivity, the urban heat island effect, biodiversity, resilience of building structures, zoning and land use patterns. Considering the future South Central Light Rail Extension, anticipated future Transit Oriented Development (TOD) opportunities and potential negative externalities. The aim is to improve connectivity within SMV equitably to expand the opportunities that will be available there.

New development often leads to gentrification; Higher property values and rents could negatively affect the residents currently living and working in the SMV area. Social equity is an integral part of Sustainability. New development can bring opportunities for economic mobility, access to healthcare and education, and fresh nutritious food as well as mixed land use, with higher density and walkability. A multi-modal transportation plan can allow for a more robust choice of transport, cost efficiency, maximize personal travel and improving the movement of goods and services.

South-Central Light Rail Corridor Extension Project

The City of Phoenix's 26 mile Valley Metro Light Rail light rail has been in operation since the end of 2008 and stretches from 19th Ave. and Dunlap Ave in upper-central Phoenix to downtown Mesa. In January 2016, the Phoenix City Council approved a light rail extension funded through the Transportation 2050 plan, in which a "six-mile South Central Light Rail Extension will connect with the current light rail system in downtown Phoenix and operate south to Baseline Road" The plan was put in place to provide equitable economic development within South Mountain Village (SMV), a region which has been in isolation for almost 10 decades.

Study Area

South Central Light Rail Corridor | Phoenix, Arizona

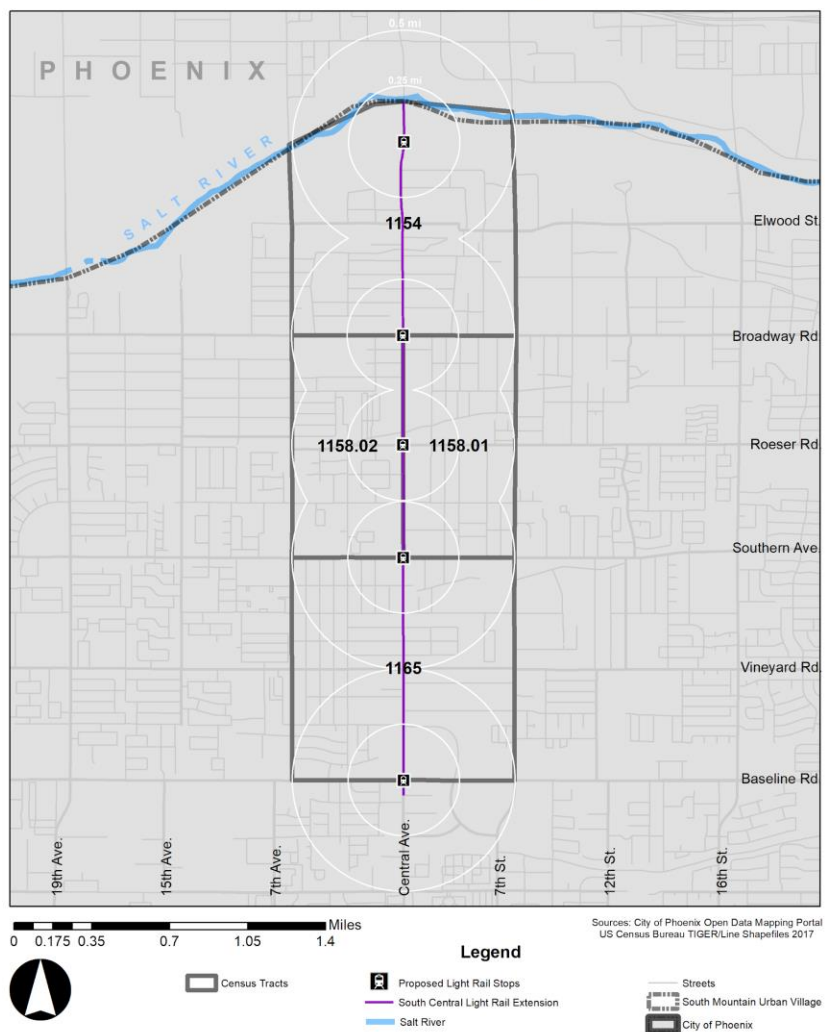


Figure 1: Study Area of the South Central Light Rail Corridor in South Mountain

The South Central Light Rail Corridor in the South Mountain Urban Village as defined for the purposes of this paper is the geographic area of the Salt River to Baseline Road between 7th Avenue and 7th Street. Totalling in approximately 3 square miles, the corridor is broken down into the following four census tracts: 1154, 1158.01, 1158.02, and 1165.

Plan

An analysis of land use assessments was used to identify potential key sites for development and adaptive reuse. Development will be based upon the Community need assessment for South Phoenix. Determine guidance and recommendations for multi-modal transportation redevelopment environmental sustainability to support heat resilience and flood protection. Incorporating affordable housing, access to healthcare, education, additional employment opportunities, improved walkability, and livability to the SMV area.

A TOD overlay along the South Central Light Rail extension would aim to provide opportunities for the adaptive reuse of industrial buildings. Research was performed to identify vacant/underutilized lots that have the potential to be turned into additional community anchors along the Rio Salado/South Central intersection to fill gaps in the community and contribute to creative placemaking. Additional on existing case studies and policies within Phoenix was performed to assess the sustainability/resilience of current buildings and land use patterns around the study area to ultimately make policy recommendations based on the results. TOD has the potential to change the paradigm for the current socio-economic status of the study region. The predominant concentration of business within the study area are owned and run by local residents. The implementation of a new light rail system could potentially enable the displacement of local business in addition to the village's vulnerable populations. This is a typical result of rising property values and rents stemming from the new transit overlay zoning. The extension of the light rail could extend the income gap between the predominantly Hispanic minority and the Caucasian population. Transit overlay development plans can yield both positive and negative externalities depending on the method of implementation. This is why we will analyze the area and information as a whole and look for an ideal method of implementation through case studies that have yielded success in similar circumstances. The next section will describe the methods that were used in conducting the assessment.

Method Overview

A site visit was performed on within focus area to see first-hand the types, locations, and condition of buildings and land (See Appendix S). Observation of the greater SMV area showed disparities in access to services and amenities. The methods include: gathering Demographic data for SMV and the study area, Conduct a Site Visit, Analyze Land Use and Zoning practices, which includes looking at the Rio Salado Area Plan, the Infill Development District and vacant lots/parcel analysis and lastly find relevant Case Studies.

Geographic Information System (GIS) was accessed from Phoenix Open Data to pull the background data that will provide a better overview of the region's need. This information will allow for the identification of current underutilized, vacant and blighted parcels for future development, in addition to the current gaps in community resources, services, and opportunities. Maps and charts were created to represent the collected data to better understand and represent the data.

Research was performed to find examples of TOD with an integration of affordable housing. Learning from other cities successes and find principles and strategies that can be applied within the project's focus area. Additional research was conducted for existing and possible green infrastructure, community gardens, and other sustainable land use solutions. This portion will focus on combating the urban heat island effect, providing shade for resident making South Mountain a more comfortable and walkable area, and help eliminate areas of food desert. All of the data and lessons learned from other Transit Oriented Developments were used to compile recommendations for the SMV development through 2040.

Methods

Demographics

South Mountain Village Demographics

SMV is one of 17 villages in the City of Phoenix. The village covers an estimated 25,481.86 acres and has a population of 111,270 people. SMV is the 8th most populated village out of the 17 villages in Phoenix and has a population density of 2.78 thousand per square mile. The majority of the population is composed of Hispanics, with an estimate of 60.3%, followed by the white population at 17.0%. (See Appendix L)

The highest median household Income (Appendix M) belonged to the Asian population cohort with \$89,300 followed by the Hawaiian with \$70,800. The majority of households are comprised of Married individuals with 39.1% followed by a One-Person household with 23.4% (See Appendix N). The unemployment rate is 7.4%, which is twice as high as the national unemployment rate of 4.1% (Appendix O)

Study Area Demographics

The total population of all four census tracts along the South Central Light Rail Corridor is 16,507 people. The median ages for all four census tracts range between 25 and 31 years indicating a relatively young demographic with the most people falling in the 25-34 Age Cohort (See Appendix D). The median annual household income for the area ranges from 25,234 to 34,231 across the four census tracts. This still overall lower than the median household income for the entire City of Phoenix which is \$49,328 and the National median income at \$55,322 (See Appendix G) (U.S. Census Bureau Quick Facts). Collectively the largest industry that employs the most people who live in the corridor area is Construction followed by Retail (See Appendix J). The population of the study area is predominantly White and of Hispanic or Latino origin (See Appendix E and G). With the largest annual household income grouping of \$15,000-24,999 (See Appendix F) and median household incomes ranging from \$25,234-\$34,231 (See Appendix G), the immediate area along the light rail corridor is of lower income. Unemployment rates across all four census tracts are fairly high between 12% and 14% with the exception 1158.02 which has an unemployment rate of 6.9% (See Appendix G and I).

Site Visit

The site visit was conducted mainly along the south-central light rail corridor extension within SMV Area. Walking surveys were performed along the public paths at Rio Salado park, near the Rio Salado riverbed, and the nearby industrial sites. The analysis primarily focused on the Valley Metro SMV Light Rail Extension along Central Ave, south of the Rio Salado to Southern Ave. Surveys around the other areas of SMV were taken to observe any differences in land use, businesses and amenities, walkability, and perceived conditions.

Starting with the riverbed, it seemed like Phoenix has turned its back on the Rio Salado. Businesses on either side of the river were set back and facing away from the river. Abandoned pieces of infrastructure were on the river banks, and the City Park near the Audubon Center looked unkempt and underutilized. There were bike riders on the trail, and one seemingly homeless person found while surveying the park. During the end of the site visit, a City of

Phoenix employee came to the ranger shack, which looked previously abandoned. The industrial zones area near the riverbed included quarries and a former landfill. There was not much activity going on, although the visit was performed on a Saturday afternoon.

Along the Light Rail Extension route, there were various auto related businesses, which will be in conflict with the forthcoming Transit Development Zoning Overlay, which in turn could have a greatly negative effect on the business owners and the community. There was not many schools, healthcare facilities, or grocery stores. Instead, the land use trends showed a high volume of small businesses and some chain fast food restaurants. Some of the businesses and the housing around this area appeared to be in poor repair. The existing vacant lots lacked plants and shade structures on the roads. Even bus stops along the sidewalk had little shade and very small areas for people to sit while they wait.

Close to the Mountain itself, the neighborhoods were more affluent, some were gated communities. There were significantly more trees and walkable sidewalks. Even the bus stops had more plants and shade structures incorporated into the design. There was a difference in the type of services and amenities available. Along the main arterial road, there were commercial shopping center with a large Target and restaurants across from on gated housing community. Within SMV itself, there were large disparities between areas in regards to shade (trees or structures), walkability, amenities, and business types.

Land Use and Zoning Analysis

The land use surrounding the aforementioned stations is mainly comprised of local commercial business with scattered concentrations of residential zoning (See Appendix B). During the site visit that surveyed the proposed transit overlay zone there was a predominance of single story commercial buildings (See Appendix A). Observing the various zoning maps, see appendix, this observation is upheld. However, the implementation of a new transit overlay district has the potential to severely disrupt the current dynamic in place. Undoubtedly, the people within this region utilize the local proprietorship of goods and services, and new terms of a transit overly may not be adherent to this emphasis on local business.

Zoning from a half mile radius around each of the five proposed light rail stations was analyzed in relation to a ten minute walking distance. Nearly one third (31.65%) of the walking radius area is zoned for multi-family residential, followed by 29.63% for single family residential (See Figure 2b). Commercial zoning is focused along Central Avenue, and along the intersections with other major arterials such as Broadway Road, Southern Avenue and Baseline Road with industrial zoning clustered at the northernmost part of the study area along the banks of the Salt River (See Figure 2a). Overall, the land use in the study area is very segregated with Euclidean zoning. Multifamily zoning acts as a buffer between the industrial and single family residential zoning.

Current zoning and land use is commercial focused, and a new transit overlay could be either beneficial or detrimental to the current residents. The area around the proposed light rail stations lacks walkability and accessibility given the transit-dependent predominant behavior within the area. Appendices S, T, and U demonstrate a broad visual of some of the walkability characteristics amongst the proposed stations. Propositions within this new overlay district should include more cooling centers both along the transit corridor, as well as within proximal residential neighborhoods.

South Central Light Rail Corridor | Phoenix, Arizona

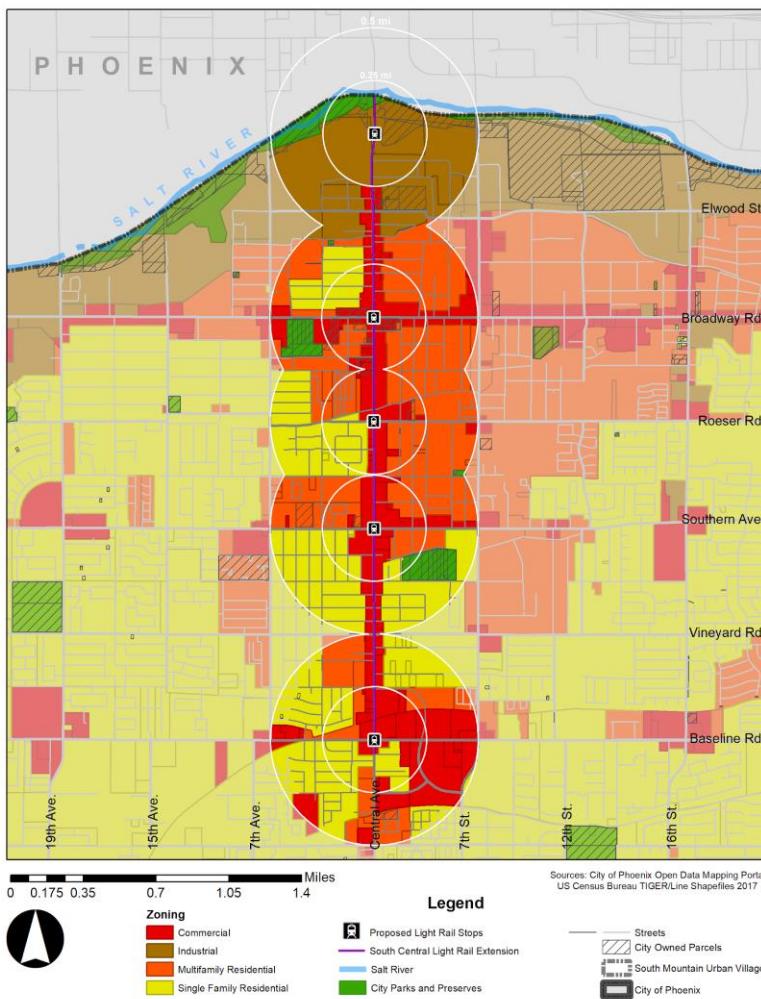


Figure 2a (Above): Zoning Map of Study Area

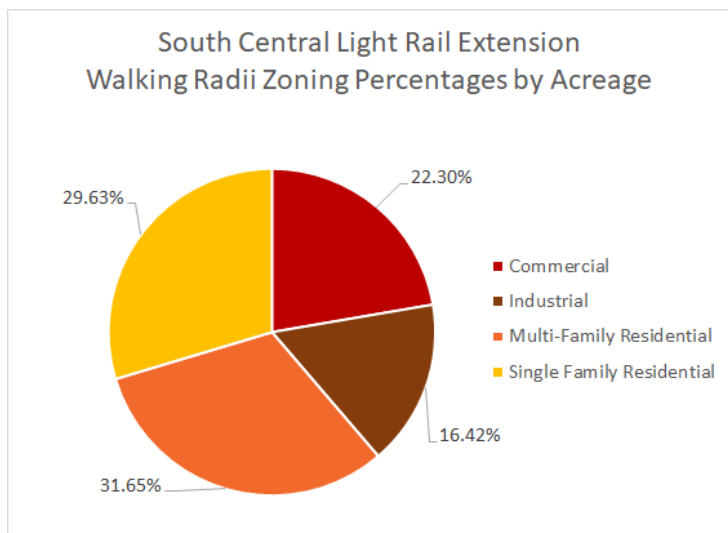


Figure 2b (Left): Walking Radii Zoning Percentages

Benefits of Current Zoning and Land Use

There are however some benefits to the current layout area around the proposed light rail stations. For one, the current infrastructure around Central Ave is already

tendered towards commercial zoning. From the site visit and through the analysis of the observations from the site visit, it's pretty clear that this commercial building district down Central Ave is mainly occupied by local businesses. These local businesses support the predominantly low income community that encircles. This dynamic promotes a social cohesiveness amongst residents whom can choose to refrain from supporting large scale corporate businesses who have a history to supply more cost demanding goods and services. During the initial site visit there was a large mass of independent automotive retailers and service buildings, a key component to remedy the inherited action of work commuting amongst the residents in the area. While the aforementioned highlights the benefits of the current zoning, there are some downsides to the current zoning and land use planning along the proposed light rail overlay district.

South Central Light Rail Corridor | Phoenix, Arizona

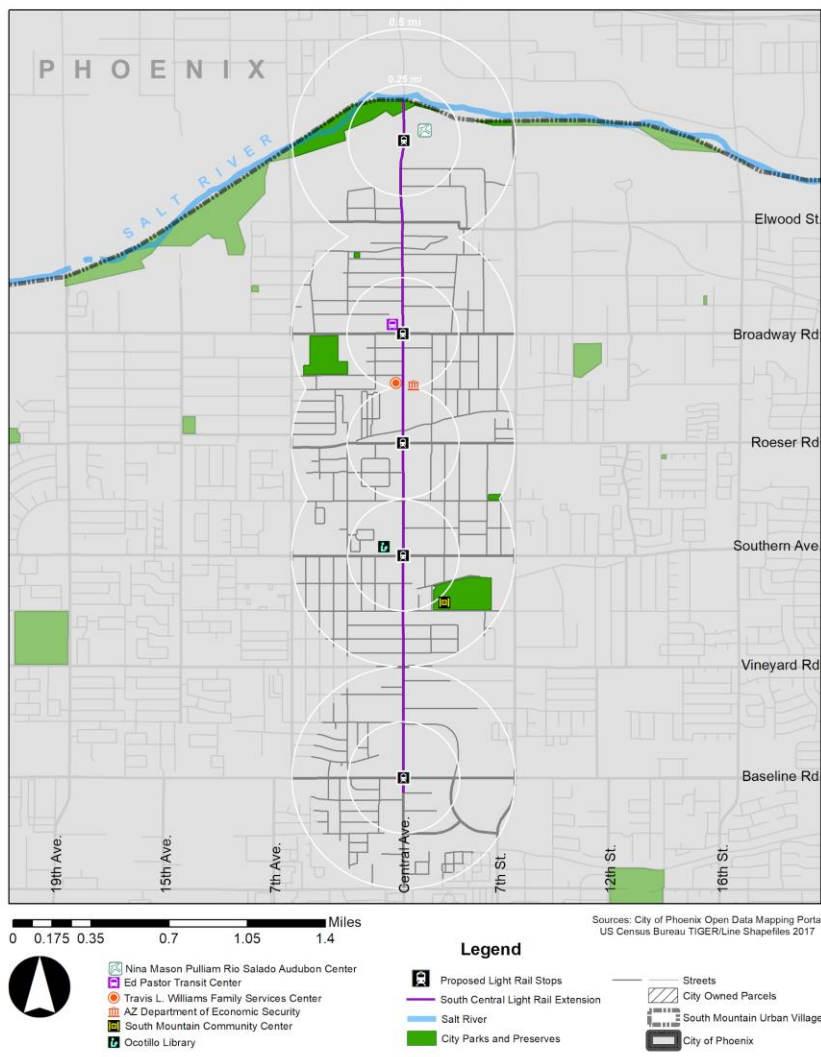


Figure 3 (Left): Proposed Light Rail Stops and Existing Public Services

Problems with Current Zoning and Land Use

A health impact assessment of the South Central Neighborhood Transit system was conducted back in 2015, and some of the data, while pertaining to the South Mountain area as a whole can be used to identify probable trends that are present within the proposed transit overlay district. The study area is 13.29 square miles and is “bound by 7th Avenue on the west, 7th Street on the east, Washington Street on the north, and Baseline Road on the south” (Lopez et.al, 2015). The zone of analyses is along Central Avenue which is included within the 2015 assessment study area. This study validated the predominance of non-

whites(Hispanics) in the neighborhood as well as the prevalence of low income households. This study also found that this section in particular is heavily reliant of transit to conduct daily

activities. The two aforementioned aspects call for infrastructure that promotes walkability to supplement elevated transit use, but the area of study showed “that heat-related deaths appear to be elevated within the study area, the absence of drinking water and shade, especially at bus stops and along sidewalks, is a substantial barrier to walkability” (Lopez, et.al, 2015). The commercial corridor along central is meant to draw in residents and promote the use of transit, but lack of land use planning to accommodate the urban heat island and safety features inhibits the effectiveness of the current zoning layout. Along with this the study found that many residents in this area lack public parks, and safe spaces to play. This reflects a lack of zoning allocated for green community space. These public spaces are more apparent towards the northern end of Central Ave and somewhat taper off the closer you get to South Mountain. This coupled with low walkability undermines the functions of this specific land use (South Central Neighborhood Health Impact Assessment).

South Central Light Rail Corridor | Phoenix, Arizona
 - Opportunities for Future Development -

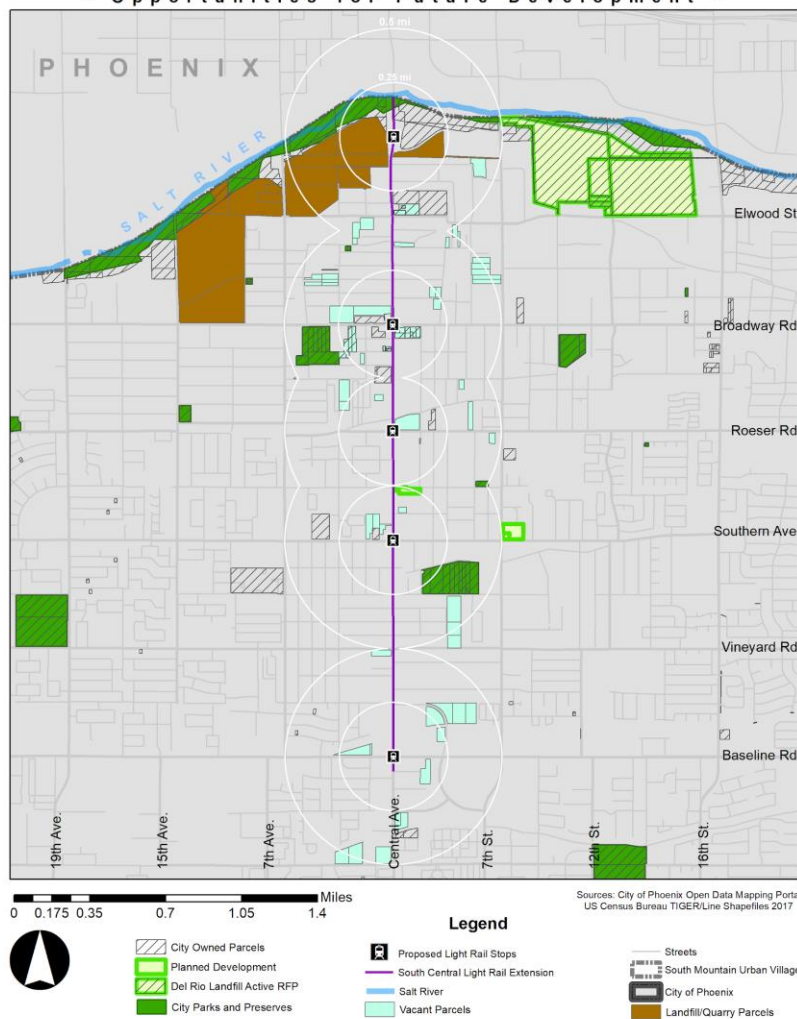


Figure 4 (Left): South Central Future Development and Vacant Parcel Map

Vacant Lots

Using satellite images of the study area, parcels that were vacant or underutilized were observed and marked. The number of vacant parcels surrounding the light rail is quite large, with the majority of these parcels ranging from 0.3-7 acres. Many of these vacant spaces are actually part of a parcel with an existing building, usually a church. This being said, the implementation of a small-scale feature such as a community garden in collaboration with the stakeholders involved can enhance the TOD within the study area and improve walkability. Other vacant parcels can be used to build a certain percentage of affordable housing to ensure that the original local community will have other housing options if rent values become less affordable.

The City of Phoenix currently has three development projects in the planning process within close proximity to the study area. According to the ABI Multifamily Construction Pipeline as of April 22, 2018, two multifamily developments are planned within the study area. On the south east corner of Sunland Avenue and Central Avenue, a developer has submitted plans for a senior living facility with 80 residential units. Another vacant lot at the intersection of 7th Street and Southern Avenue has filed plans for a 90 unit multifamily development for UMOM. Both sites are highlighted in Figure 4 as planned development. The City of Phoenix recently closed on the submission process for the Del Rio Landfill RFP on April 24, 2018. This RFP focuses on the redevelopment of a former landfill site just south of the Salt River between 7th Street and 16th Street. Totalling in 156 acres, this massive collection of parcels stands as a significant development opportunity along the river and in close proximity to the study area. The Del Rio RFP outlines the proposal for the development of a regional park on the site under the Beyond the Banks Area Plan and the Del Rio Brownfield Redevelopment Plan.

Rio Salado Beyond the Banks Area Plan

In 2003, the City of Phoenix Planning and Development Department Published the Rio Salado Beyond the Banks Area Plan to focus redevelopment of the land in direct proximity to the Salt River in the Central City and South Mountain Urban Villages. Focusing on existing land use, the plan established the Rio Salado Interim Overlay District which functions as a transitional zoning measure to encourage a shift in land use from predominantly industrial uses. Considering future redevelopment the Rio Salado Interim Overlay District (See Figure 5) guides industrial development to follow the construction guidelines and standards for the Commerce Park. By restricting development of junk and salvage yards and limiting industrial uses to be predominantly indoor, Phoenix hopes to guide future development and prevent extensive land pollution. The Beyond the Banks Area Plan further highlights land use goals for the southern bank of the river in South Mountain such as phasing out incompatible land uses, transitioning to predominantly residential, and rezoning for higher density reflective of market demands. The Beyond the Banks Area Plan acts as an additional guide to future land uses and should be at the forefront of land use in the northern part of the study area north of Broadway Road.

Rio Salado Interim Overlay District, City of Phoenix, Arizona

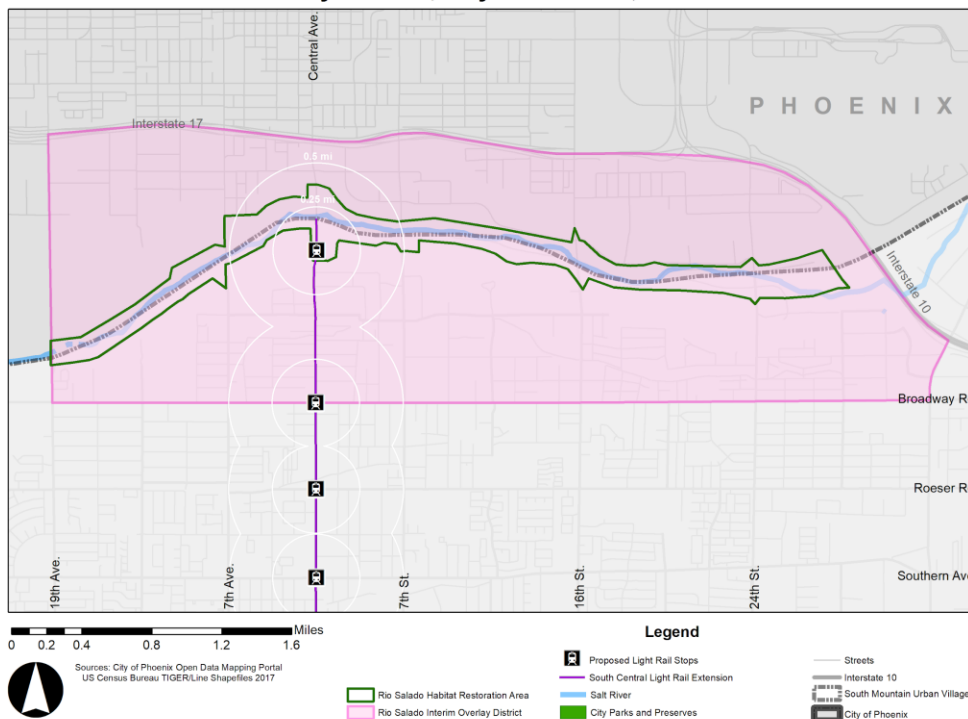


Figure 5: Rio Salado Interim Overlay District Map

Del Rio Brownfield Redevelopment Plan

In 2012, the City of Phoenix adopted the Del Rio Area Brownfields Plan which identified key brownfield sites along the banks of the Salt River for redevelopment. City officials engaged in a public process to gain insight into the future development of three sites located between 7th Avenue and 16th Street. This included the Del Rio Landfill, a 70 acre privately owned site west of Central Avenue and a 10 acre site just south and south east of the Audubon Center which is also privately owned. The plan identifies multiple potential future land use arrangements for each of the sites ranging from parks, residential mixed use, and educational/medical/research facilities. Such a process could be expanded upon for the inclusion of other vacant parcels within the study area while providing a contextual example for brownfield redevelopment in the area.

Infill Development District

The Infill Development District plan was adopted in 2011 as a part of the Phoenix General Plan and was developed as an initiative to repurpose vacant lots and reduce urban sprawl. In Phoenix, the district follows along the light rail corridor and downtown core. The zoning ordinance was later amended in 2013 to expand it to its current boundary at to Broadway Road roughly between 7th Avenue and 7th Street in the South Mountain Village. This however does not include the full length of the proposed South Central Light Rail Extension.

Additional Infill Development Initiatives

Additional infill initiatives include 1) Vacant Lot Activation, which “allows for passive vacant lot usage by right for art installations, pocket parks etc. along the light rail line and establishes a use permit process for vacant lot activation on any parcel in the Reinvent PHX planning area” (City of Phoenix, 2013) and 2) Mobile Food Vending, which “allows mobile food vending (food trucks) on private property within the Downtown Code and the ReInvent PHX” (City of Phoenix, 2013). The Single Family Attached Allowable Development Area, shown in Figure 6, highlights the portion of the study area north of Southern Avenue that is eligible for such SFA housing infill development. This is an opportunity for housing densification and creation of additional housing units on the larger residential lots that currently only have a single housing unit occupying a very small portion of the entire lot. The Housing Development Area covers the entire study area and has been identified from the city as a targeted area for additional housing units (See Figure 6).

South Central Light Rail Corridor | Phoenix, Arizona



Figure 6 (Left): Infill Development District, Housing, and Single Family Attached Development Areas Map

Case Studies

Transit Oriented Development

In the United States, housing and transportation costs are often the two largest expenditures for households. Unfortunately, for those who need affordable housing, it is often located outside of the urban core, driving up their transportation costs and negating the savings on housing. According to the Department of Housing and Urban Development, typical households in auto-dependent neighborhoods spend about 25 percent of their income on transportation costs, but this number drops to nine percent in neighborhoods with a variety of

mobility options. The savings of both dedicated affordable housing and decreased transportation

costs allows these families to save for homeownership or market-rate housing, spend more money in the local economy, and spend on essential services such as healthcare. These benefits are not just individual, but societal as well, as they place less strain on social services and resources. (Ryan, 2016) The improved location of affordable housing also provides access to a wider job market, while taking more cars off the streets. Appropriately scaled and distributed affordable housing, such as that near transit, prevents pockets of poverty, and has been shown to have no negative impacts on surrounding property values.

One option to make transit-oriented affordable housing a reality are tax credit points for transportation. One way to promote this development on a national level is through the allocation of Low-Income Housing Tax Credits. Another option is a housing protection district, for example, in Columbia Pike, Arlington County a ‘Special Affordable Housing Protection District’ is included in its General Land Use Plan. The SPAHD protects affordable housing sites along Metro corridors by stipulating that they be replaced on a one-for-one basis in most new developments. The initiative protects vulnerable committed affordable units as areas in the county's Metro corridors become even pricier.

Affordable housing creates more diverse and economically sustainable communities. If put into practice for the SMV, it could help the current residents and community stay in the area after the new development, and be able to benefit from the other amenities and services, while protecting affordable housing and other local businesses.

Fruitvale Village | Oakland, CA

Fruitvale Village was a \$100 million mixed-use development that opened in 2004. The development included 47 housing units (including 10 affordable), community services for seniors and youth, a Head Start center, pediatric clinic, union office, several small businesses and eateries, charter high school and a weekly farmers market. Fruitvale saw higher growth in household incomes when compared to similar neighborhoods in the Bay Area and the State. There was an increase in number of residents graduating high school and going on to earn a bachelor’s degree. Across the state and the Bay Area, the proportion of residents buying their homes fell, while in Fruitvale, the number of home buyers actually increased. Researchers did find that rents rose in Fruitvale 83 percent, compared to 71 percent in similar Bay Area neighborhoods, and 66 percent in similar California neighborhoods outside of the area. In continuing the growth and development, the Unity Council recently broke ground on a 94-unit affordable housing tower at the Fruitvale transit village with plans to construct another 181 market rate units and retail businesses in the near future. (Baldassari, 2018)

Fruitvale has being hailed as the ‘holy grail’ of urban planning, showing improvement of place, and residents better off after the development. Some of the initial research shows positive change and community development. There was still higher rent increased than surrounding areas. There are crucial lessons to be learned from this project that can be transferred for use within the assessment and recommendations provided for SMV. The types of development and programs that went in with the development were chosen and implemented to increase opportunities for and capacities of residents. Community assessment and involvement is necessary to understand what types of development, programs, amenities, and support the SMV really needs so that future development and growth can be sustainable and socially equitable.

Edison-Eastlake Community CNI | Phoenix, AZ

In June 2016 the City of Phoenix was awarded a \$1.5 million Choice Neighborhoods Planning and Action Grant from the U.S. Department of Housing and Urban Development (HUD) for the Edison-Eastlake Community. The Choice Neighborhoods Initiative (CNI) is a grant from HUD to transform distressed neighborhoods and public housing into mixed-income neighborhoods linking housing improvements with appropriate services, schools, public assets, transportation, and access to jobs. Choice Neighborhoods is focused on three core goals: housing, people, and neighborhood. Some of the goals are to replace distressed public housing with high-quality mixed-income housing that is well-managed and responsive to the needs of the surrounding neighborhood, improve educational outcomes and intergenerational mobility for youth with services and supports delivered directly to youth and their families, and create the conditions necessary for public and private reinvestment in distressed neighborhoods to offer the kinds of amenities and assets, including safety, good schools, and commercial activity, that are important to families' choices about their community. (City of Phoenix, 2017)

Lessons that can be applied to the SMV are: consider health as the physical, mental, and social wellbeing of people; facilitate community resilience, thoughtfully plan the food environment; enhance environmental quality; foster an active, safe community. Make a plan for mixed-income and affordable housing along the light rail extension. These guiding principles set an example for considerations in reference to supporting facilities and programs that increase educational opportunities, create an environment conducive to local businesses thriving, and development of new businesses and amenities to benefit the immediate community, and SMV as a whole.

ReInvent PHX | Phoenix, Arizona

In 2012, the City of Phoenix, in collaboration with Arizona State University, the U.S. Department of Housing and Urban Development, Valley Metro and various other local organizations and community groups embarked upon Reinvent PHX, an initiative focused on quality development along the light rail corridor. Through a series of intentional public engagement activities, Reinvent PHX developed a series of community based TOD plans for the initial stretch of the light rail line in Phoenix. The five district policy plans outline objectives in civic engagement, quality development, a smart growth model and return on investment. Each of the district policy plans were accompanied with a five year action plan for implementation. In 2015, the Phoenix City Council adopted the five TOD District Policy Plans and adopted the Walkable Urban Code (WU Code) for the Downtown Core.

The Walkable Urban Code in Chapter 13 of the Zoning Ordinance that has a strong focus on using green infrastructure to improve sidewalk, land use, mobility, health and economic development conditions. Transects are zoning codes designed urban and TOD for corridors along the light rail. Previously, the WU code was utilized for the implementation of the Reinvent PHX Transit Oriented District plans for the Eastlake-Garfield, Uptown, Midtown, Gateway and Solano regions.

Transects are essentially sub-sections within zoning and correspond to the TOD's development intensity, uses, parking, streetscape, frontages, setbacks and coordinating height among additional zoning elements. The WU code is different as it functions as a sort of form-based code which pays close attention to the exterior form of buildings that typical Euclidean zoning ignores. The Southern Extension corridor is primarily comprised of low-intensity residential districts. Within the Walkable Urban Code, suggestions for improvements are made

within a $\frac{1}{4}$ to $\frac{1}{2}$ mile radius along the light rail to improve accessibility to the station. The design features of this plan use structural shade elements, public art, seating, light fixtures, trees, and additional bike racks to support walkability. Additionally, the urban code suggests that microclimates and environmental conditions can be moderated through the integration of trees and landscaping to improve air quality, lower noise pollution, provide shade, reduce hot pavement and other factors that add the pedestrians' comfort and convenience.

The purpose and intent for the WU code are to protect land use values through creating comfortable, safe, and economically productive districts that surround the light rail states and provide walking and bicycling between and within the separate transect district. In giving a walkable bikeable and transit-supportive development environment, it will allow for the integration of auto-oriented and industrial and mixed land use increasing connectivity for both pedestrian and vehicle routes to form smaller block sizes. Additionally, the WU code aims to improve the population and employment of the region through the usage of infill development (Phoenix Zoning Ordinance G-6409, 2018). Improvements within the Southern Extension corridor should reflect the Walkable Urban Code for urban and TOD based development, and span a $\frac{1}{2}$ radius mile to improve overall walkability increase connectivity to public transit and improve the walk score within the corridor.

Healthy, Equitable Land Use Network (HEALU) | Los Angeles, CA

Land use developments shape the social, economic and environmental conditions within a community and are a key indicator of access to health resources. In Los Angeles, gentrification and population displacement were found to be exacerbated by well-intended health-promoting land use developments for the creation of green spaces, TOD, and bike lanes. As a result, the Prevention Institute and various stakeholders researched opportunities to promote health and social equity for the land use developments in Los Angeles and in 2012 they formed the Healthy, Equitable, Active Land Use Network (HEALU). Their findings suggested that the creation of active spaces that are conducive to physical activity are a key parameter within current land use trends, but the disproportionate investment for healthy opportunities within vulnerable Latino and African American populations were found to increase their risk to chronic health diseases and violence.

The HEALU Network identified key leverage points for opportunities within land use planning to promote health equity in their development. The mission of the HEALU Network is to strategically increase the percentage of public capital invested in health-promoting infrastructure in low-income communities of color through building governmental and community organizations that allow for robust community engagement in land use planning and policy making. The HEALU aims to accelerate land use innovations and pilot projects within low-income communities of color and foster cross-government collaboration to embed health and equity in all land use decisions (Leung et al., 2016; Prevention Institute, 2016).

Opportunities for incorporation of agencies similar to HEALU could be implemented within the Arizona Department of Health Services Crisis Prevention Institute. This will allow for a precautionary decision-making process that accounts for the effects of gentrification from transit-oriented land use developments.

Urban Agriculture in Urban Heat Islands | Toronto, Canada and University of Arizona

Half of the world's population currently lives in urban regions, and the concentration of people within these regions is expected to increase over time. Urban areas tend to experience

higher temperatures in comparison to rural areas due to the environmental conditions associated with the urban heat island effect. Heat does not dissipate under urban heat island conditions and as a result plant growth rates are slowed due to less evapotranspiration occurring within the soil. However, the longer and warmer growing conditions during mild winters for various cities provide a climatic difference for the growth of species that are not suitable within rural conditions.

A study performed in Toronto, Canada found that urban conditions allow for an earlier onset of the plant phenological spring growth phases and the plants consistently flowered before their rural counterparts. It is essential to incorporate the effects of heat tolerance and warmer nights for the selection of plant in Phoenix to choose species that take advantage of the urban heat island effect. The findings of this study suggest there is a potential for growing warmer-climatic crops within a region experiencing UHI, allowing for the creation of a niche market for urban farmers to grow specialty crops and increase the production diversity within the selection of local produce (Waffle et al., 2017). Ultimately, the study's results suggest that planners can make use of the hottest and most uncomfortable spaces within urban areas such as parking lots, rooftops, and courtyards for food production.

Urban agriculture allows access to healthy and affordable food, and provides a vegetable-rich diet, which could eventually contribute to diminishing chronic diet-related illnesses such as obesity, diabetes, and cardiovascular disease. Urban agriculture methods consist of vegetated roofs, aquaponics, hydroponics, greenhouses, plant factory with artificial light and remote skylighting. A study performed by the University of Arizona found positive impacts associated with mitigating UHIs in arid regions through the integration of agriculture within the built environment. However, it requires complex conditions for vegetal services to develop, such as water accessibility and technical services that support the growth of crops (Camacho and Chalfoun, 2016). The employment of technical jobs that promote green infrastructure in cities contributes to energy efficiency improvements and the development of self-sufficiency in communities. The implementation of urban agriculture in arid regions can positively influence Phoenix by reducing air pollution, increasing food security, improving soil quality, allowing for runoff and rain collection in addition to lowering fossil fuel consumption associated with the transportation of food.

South Central Neighborhoods Transit Health Impact Assessment (SCNTHIA)

The SCNTHIA report was conducted by the Maricopa County Department of Health in collaboration with the City of Phoenix for identifying potential community health impacts from the proposed South Central Light Rail Corridor. The Health impact Assessment serves as a tool for decision makers to analyze the state of public health within a given area prior to development and redevelopment. From 2013 to 2015 and advisory group of community stakeholders identified the following key target areas to improve health outcomes: Shade/Security, Transportation Costs, Business/Employment, Housing, Access to Fresh Produce/Healthcare, and Active Transportation. Collectively the implications to health outcomes were quite troublesome, especially for specific groups with unique health conditions. Despite the research points to the idea that higher access to public transportation can have positive impacts, while simultaneously possessing safety and reliability concerns for residents. This study holds heavy significance because often times, the affected communities are commonly overlooked with regards to their health implications.

In recognizing disparities in the built environment disproportionately impact low income minority populations, the neighborhoods along the proposed South Central Light Rail Extension Corridor are no exception. SCNTHIA outlines negative health impacts from food insecurity, poor walkability and pedestrian infrastructure, and the urban heat island. Inevitable gentrification from the light rail introduction could displace current residents and small businesses from rising property values. To address such concerns, SCNTHIA outlines recommendations for mitigating current and potential future negative impacts.

This study also provided additional strategies that would be beneficial to the implementation of this new transit infrastructure associated with the light-rail extension such as the inclusion of green infrastructure. The lack of pedestrian-friendly infrastructure has plagued the community's ability to navigate through the study area. This is due to the increasing temperatures, lack of sufficient pathways and walkways, and the material used for building around the South Central Corridor. The study suggested expediting the slow progression of the 25% canopy coverage by 2025. Aside from the SCNTHIA study, there is tangibility in the reason for speeding up this process. "It has been found that trees within the community actually reduces crime and adds property value to the area. While it may be overlooked, trees also have the capability to slow traffic, reduce noise, cool sidewalks to encourage walking". (Ponnekanti, 2016) This would especially beneficial to the special needs populations. This green infrastructure has many tangible benefits to the population that it serves. Unfortunately, according to the Phoenix New Times, "Phoenix still has not created a formal Tree and Shade Committee to oversee the urban forest as required by the tree master plan, which the City Council passed eight years ago" (Flaherty , 2018)

Additional recommendations that should be adopted to ensure proper transit implementation and mitigated gentrification include the following: Infrastructure that promotes shade and security should also equally facilitate walkability within the neighborhood landscape. Transportation costs should remain conducive to the necessity of affordable goods and services within the area. The business district along the corridor should provide equitable opportunity for community residents to create a system which keeps revenue within the community and fights against outsourcing and major commercial retail intrusion. Healthy standards of living that are incentivized by government programs should also become the norm to prevent younger and wealthier generations from flooding into the TOD district. Food security and the elimination of food deserts should become a necessity to facilitate better health amongst the residents within this community who currently lack sufficient food choices for sustenance. Lastly transportation should be equitable and appropriate to the income demographics of the surrounding population to maintain community equity and access to a better life. All recommendations would ensure fluidity of the new transit system and higher standard of living for residents within the area.

Singapore's Solution to Sub-standard Transit Stations

There are other opportunities for the city to explore to facilitate better walkability and transit usage. The city should "explore partnerships with local businesses to fund expanded construction of cooling centers that utilize solar powered fans/misters/water fountains at existing and future light rail stations and bus stops"(Lopez et.al, 2015). The "Smart Bus Stops" being implemented in Singapore provide one example of what these cooling centers might look like.

In Singapore, it was concluded that there are more negative externalities concentrated within bus station than in the surrounding area. According to the National Research Foundation,

‘you may be polluting your lungs with 3.5 times more fine pollutant particles at bus stops than anywhere else. Furthermore, these fine particles from vehicle emissions are 100 times smaller than the PM2.5 pollutants. It’s beyond the question of just temperature, significant health impacts such as corroding the walls of your lung air sacs, worsening of heart diseases, and even stroke are elevated within the confinement of bus station’(Temasek, 2017). Bus stations such as the “Smart” model which utilizes the “Airbat” model filters out the harmful particulates in the air and also can lower temperatures within the station area by as much as 24 degrees Celsius. The contraption inhales hot air around the station area and produces cool air to those within the confinement of the station. This technology would further increase the attractiveness of using transit, and would complement the TOD infrastructure to be put in the transit overlay corridor.

Current Recommendations/Propositions

From the aforementioned methodologies and research, the following recommendations outline a path towards sustainable, community based transit oriented development along the South Central Light Rail Corridor. In order to have greater community investment and backing with the proposed light rail extension and transformative development, Phoenix should be intentional with developing a community based vision for TOD as in ReInvent PHX. Considering the current lack of shade and resilient infrastructure, the proposed TOD Overlay should account for the integration of green infrastructure into development and redevelopment projects to improve quality of life and health outcomes. Lastly, Phoenix has the opportunity to maximize the equitability of future development along the corridor through land management and policy decisions. By amending current land use policies to include the study area and utilizing economic development incentives such as the Government Property Lease Excise Tax (GPLET), Phoenix can attract development that fulfills community needs and mitigates potential negative impacts from gentrification and the urban heat island effect.

Community Based Transit Oriented Development

- Adopt a community-based vision for development with extensive public engagement
- Create a connected, walkable community
- Encourage economic development, preserve agricultural history
- Create safe and economically viable developments for walkability
- Integrate health and equity within land use decisions
- Explore the attainability of shared-use agreements to open public establishments, such as playgrounds and other school facilities, as community recreation and gathering space

Integration of Green Infrastructure and Urban Agriculture

- The TOD overlay could be used to protect the integrity of the land and ensure agricultural viability by:
 - Protecting quality of surface water
 - Protecting groundwater quality and quantity
- Managing storm water and preserving forestry integrity
- Preserving sensitive area/wildlife habitat and protecting aesthetics of the natural environment

- Using flexible and agile Green Infrastructure Systems that incorporate Urban Agriculture
- Using vegetative roofs that serve to collect rainwater

Best Land Management Practices & Policy Recommendations

- Promote Sustainable development in vacant lots that fulfill gaps in community needs
- Adopt Sustainable Development Design Guidelines
- Utilize GPLET for inclusion of affordable housing
- Leverage City owned parcels for quality TOD in the RFP process
- Expand Infill Development District down to Baseline Road between 7th Avenue and 7th Street
- “To minimize displacement, explore a property tax freeze or cap for existing low-income homeowners whose home values may increase upon LRT corridor completion; and provide tax incentives to rental properties to maintain the number of low income units available” (Lopez et.al , 2015).
- To mitigate gentrification, prioritize affordable mixed-used, mixed-income, higher density housing development along transit corridors already included in the current U.S. Department of Housing and Urban Development (HUD) and the Arizona Department of Housing’s Five Year Consolidated Plan(Lopez, et.al, 2015)
- Engage rental property owners, especially those providing housing to low-income tenants, to promote the Valley Metro Reduced Fare Program(Lopez, et.al, 2015)
- Expand ReInvent PHX and adopt TOD overlays for the South Central Extension
- Intentionally act upon the recommendations outlined in existing plans and reports such as: the Rio Salado Beyond the Banks Area Plan, the Del Rio Brownfields Area Plan, the Tree and Shade Masterplan, and the SCNTHIA Study

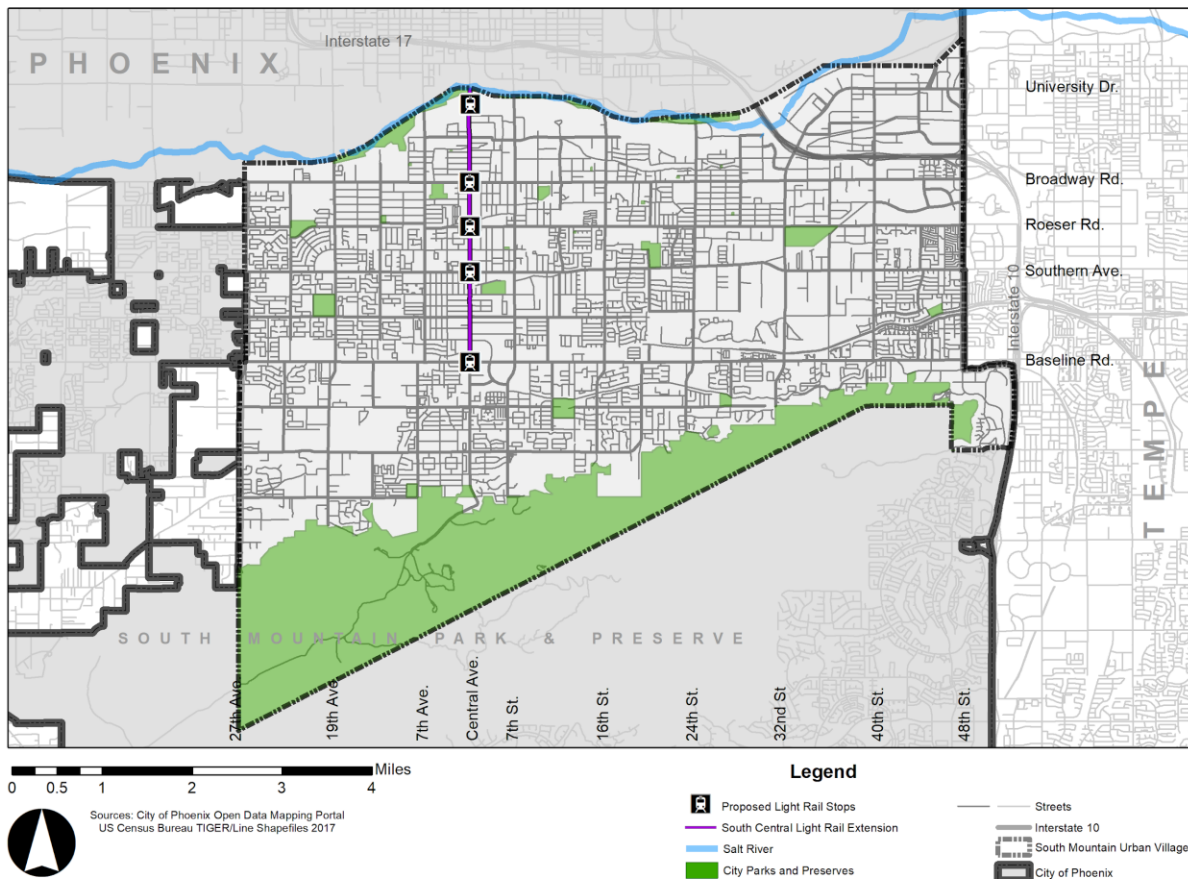
Conclusion

This project explored the building and land use within the South Mountain Village (SMV) area. The South Central Light Rail extension corridor was the focus area, taking into consideration a half mile radius around each of the five proposed light rail stations. Research of the area included analyzing SMV demographic information, land use and zoning, a site visit, investigation of relevant case studies, and information on current City of Phoenix, and other transit oriented development plans. Based on the results of the research and examples found in many case studies, recommendations were made in the following areas: 1) The implementation of a community-based transit oriented development 2) The integration of green infrastructure and urban agriculture, and 3) Best Land management practices and 4) policy. The goal of these recommendations is to promote sustainable development while mitigating gentrification. SMV has the potential to be a connected, equitable, and sustainable community.

Appendix

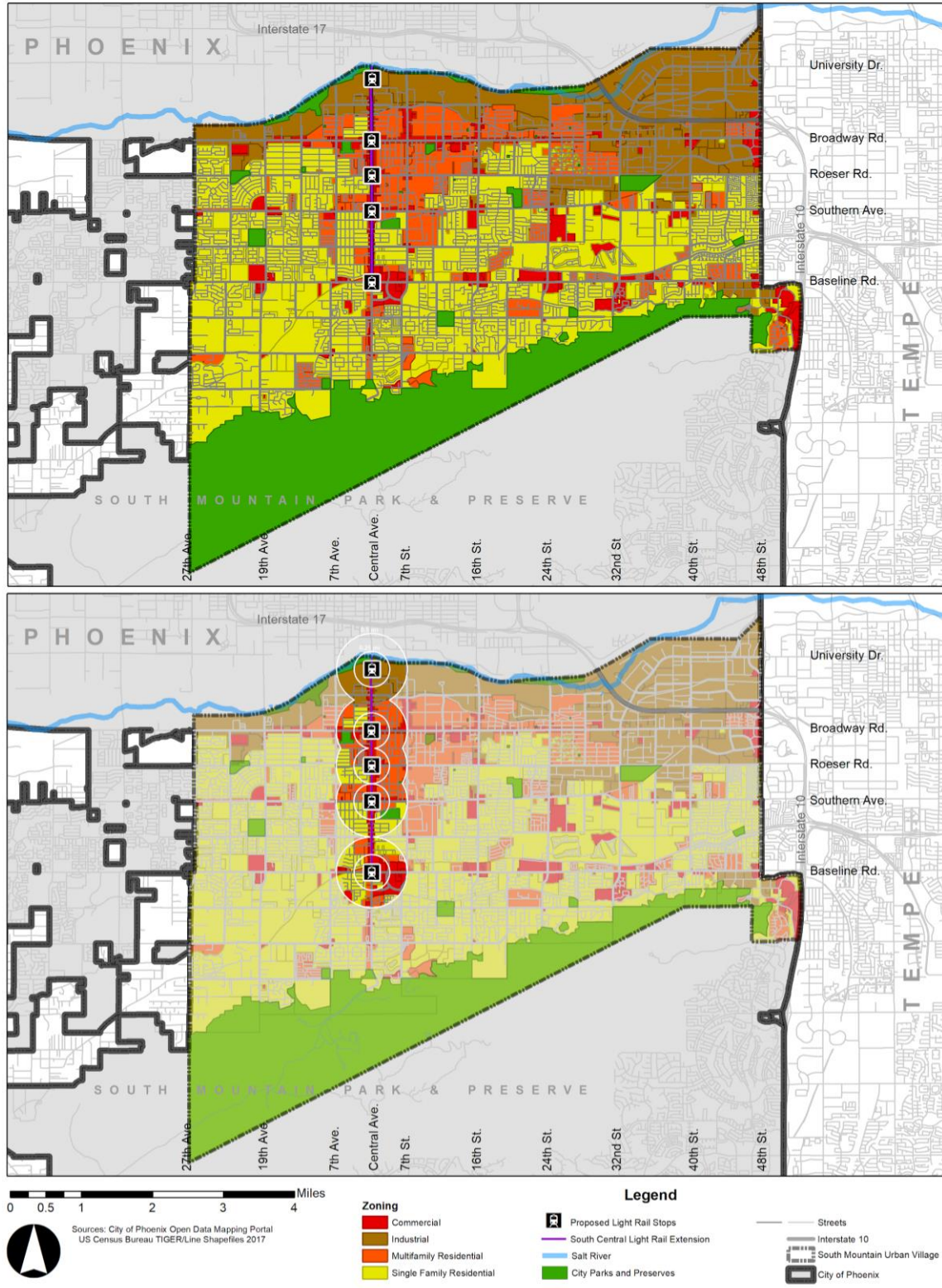
Appendix A: Map of the proposed South Central Light Rail Extension in the South Mountain Urban Village

South Mountain Urban Village, City of Phoenix, Arizona

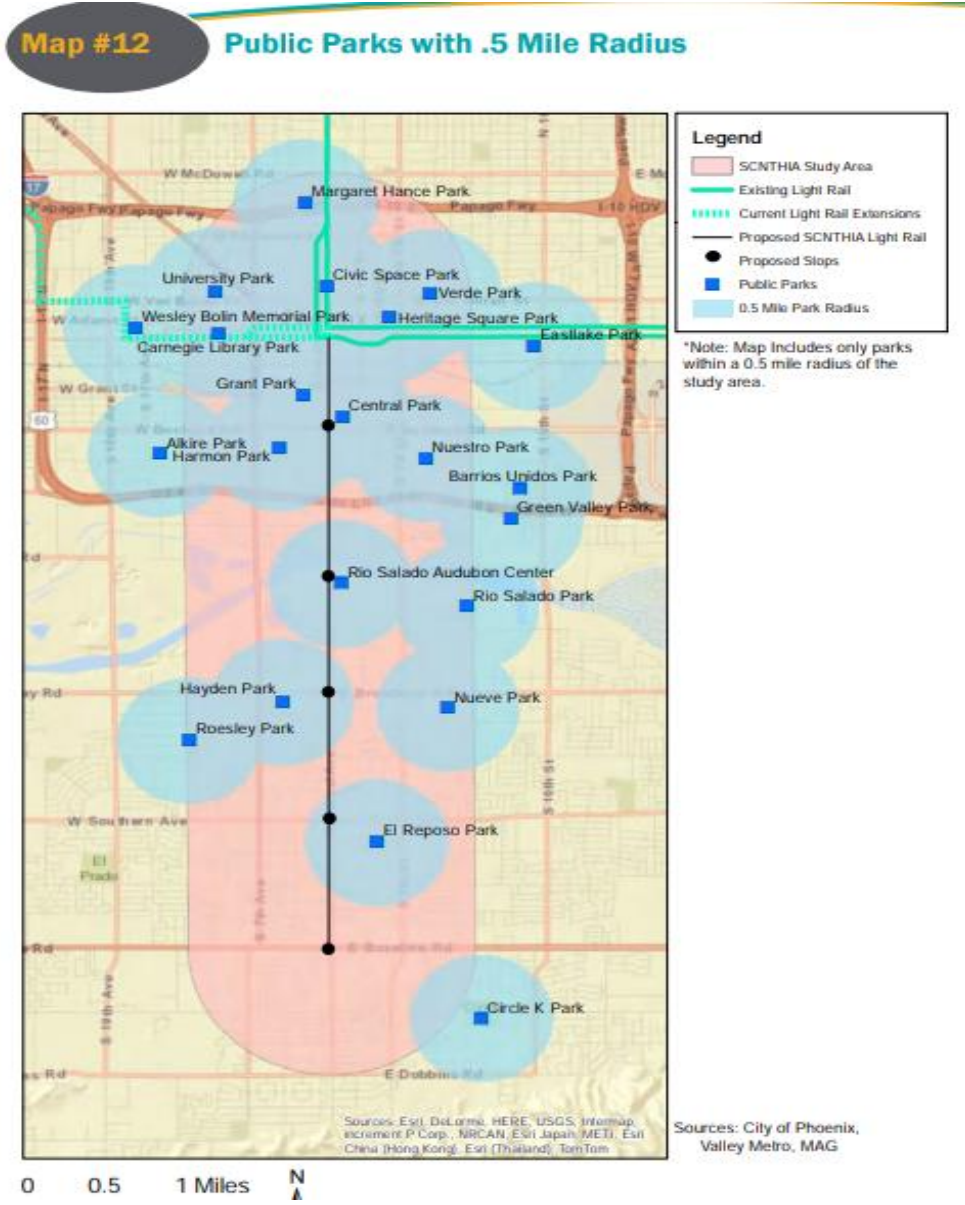


Appendix B: Zoning Map of South Mountain Urban Village and Study Area

South Mountain Urban Village, City of Phoenix, Arizona

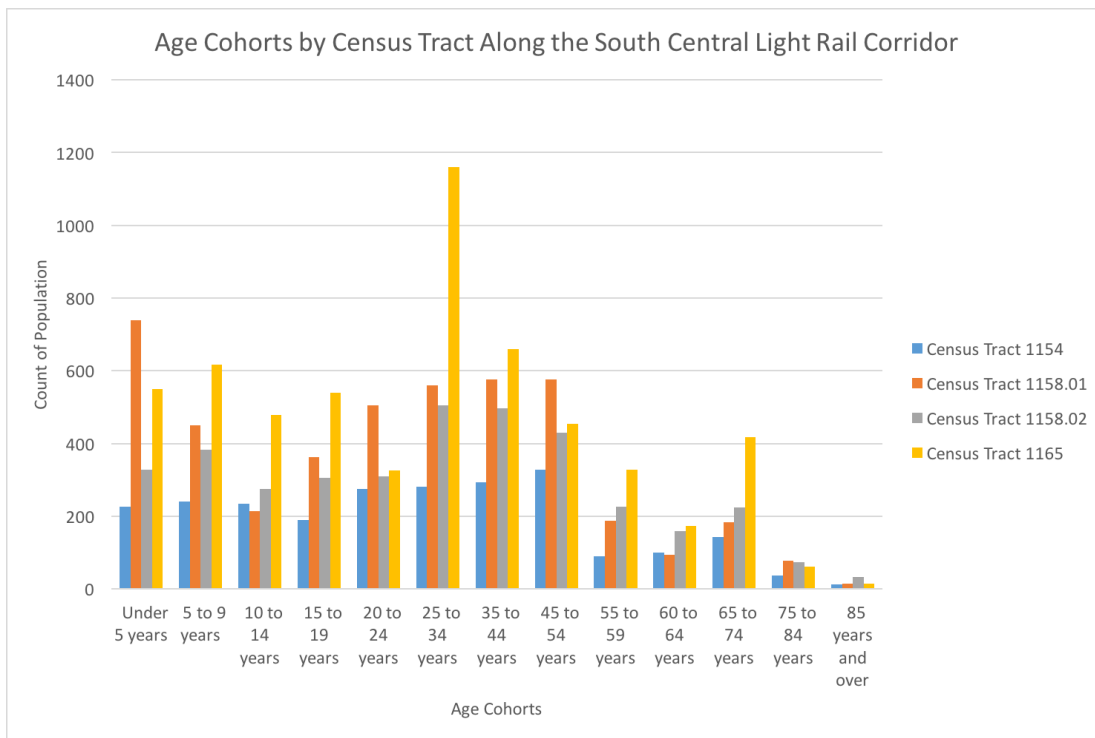


Appendix C: Public Parks within The Study area



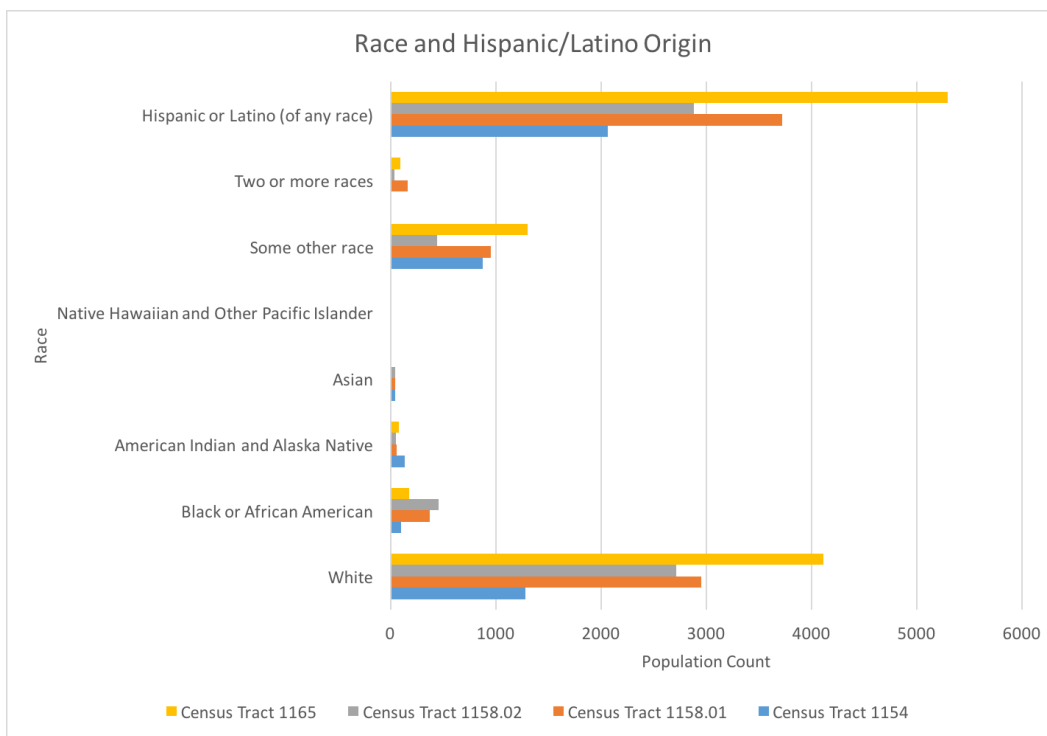
Source: South Central Neighborhoods Transit Health Impact Assessment 2015

Appendix D: Age Cohorts for Census Tracts 1154, 1158.01, 1158.02, and 1165



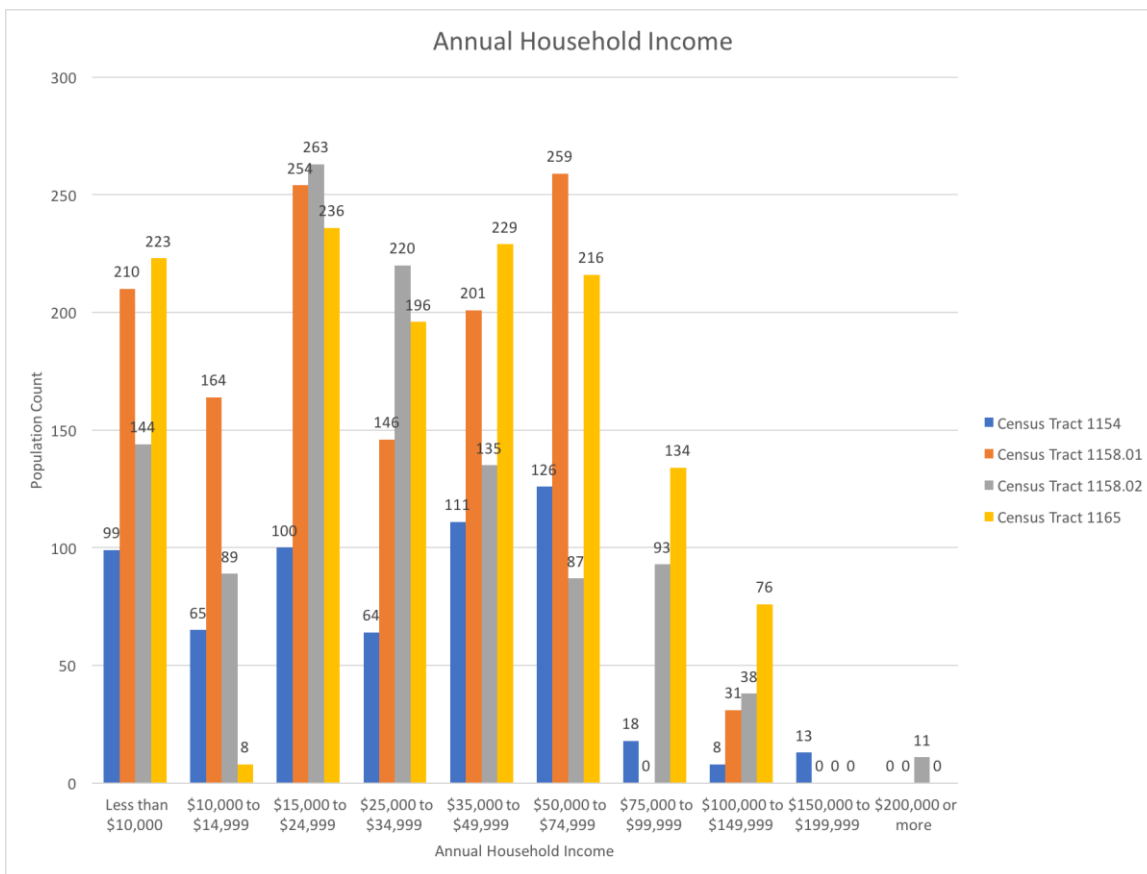
Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05.

Appendix E: Race and Hispanic Origin for Census Tracts 1154, 1158.01, 1158.02, and 1165



Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05.

Appendix F: Annual Household Income for 1154, 1158.01, 1158.02, and 1165



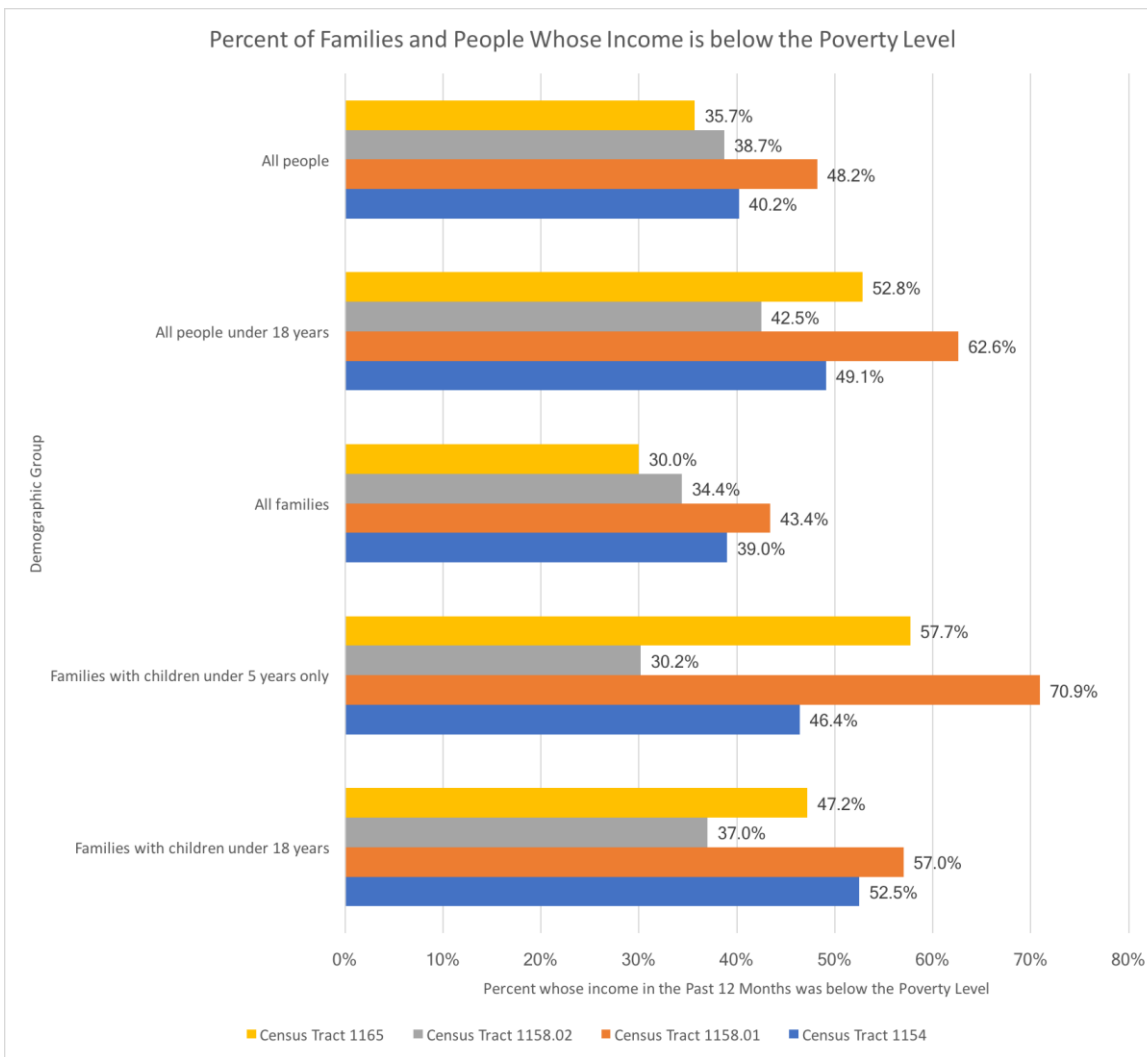
Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05.

Appendix G: Select Demographic Characteristics Snapshot of Study Area Census Tracts

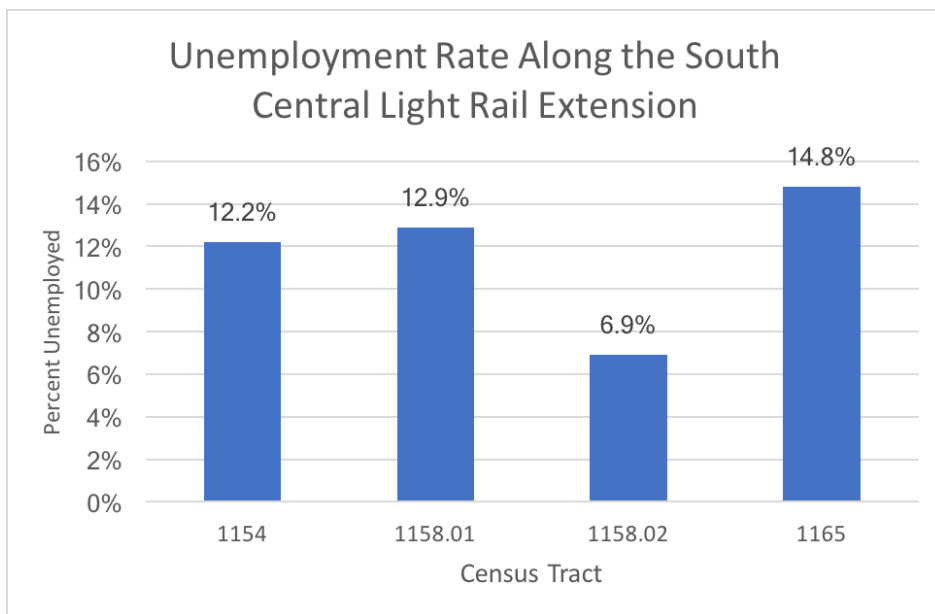
	Census Tract 1154	Census Tract 1158.01	Census Tract 1158.02	Census Tract 1165	Census Tracts Total:
Population	2,445	4,539	3,746	5,777	16,507
Median age (years)	27.5	25	31.7	28.3	
Hispanic or Latino (of any race)	2,067	3,724	2,884	5,296	13,971
Median household income (dollars)	\$29,688	\$25,234	\$27,075	\$34,231	
Unemployment Rate	12.2%	12.9%	6.9%	14.8%	
Percent People Whose Income in the past 12 Months is Below the Poverty Level	40.2%	48.2%	38.7%	35.7%	

Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05. Note: Unemployment rate calculated as a function of unemployed population as a percent of population in the labor force as defined by the U.S. Census Bureau.

Appendix H: Percent of Families and People Whose Income is Below the Poverty Level



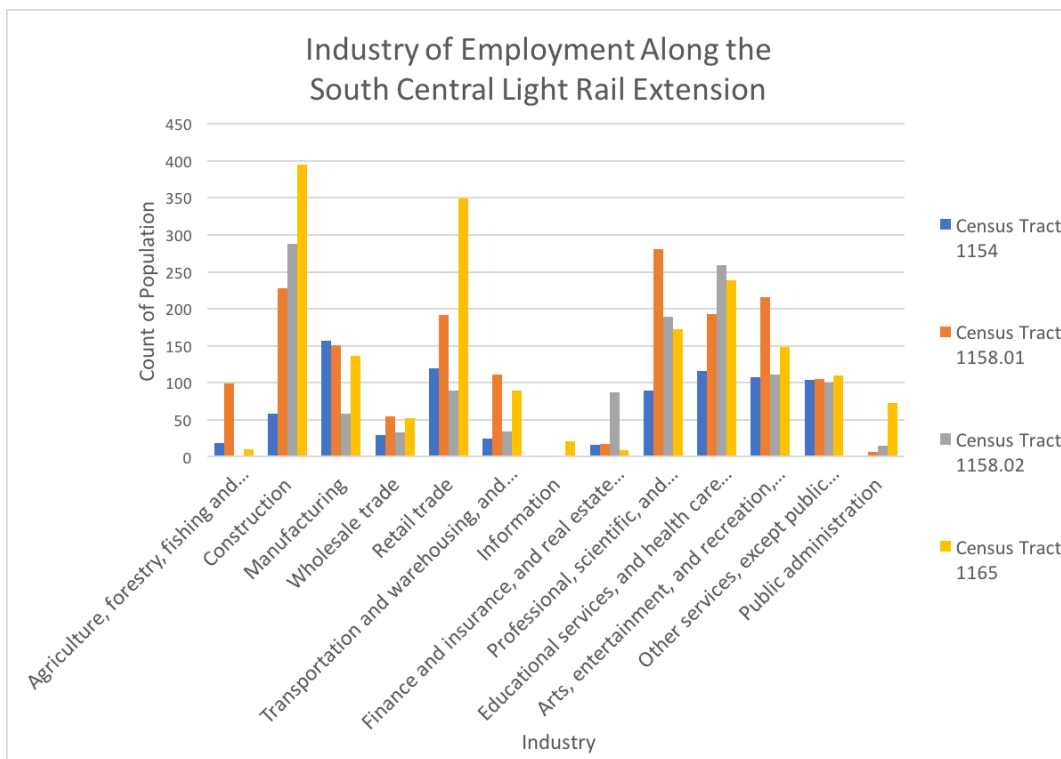
Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05.



**Appendix I:
Unemployment Rate
Along the South
Central Light Rail
Extension**

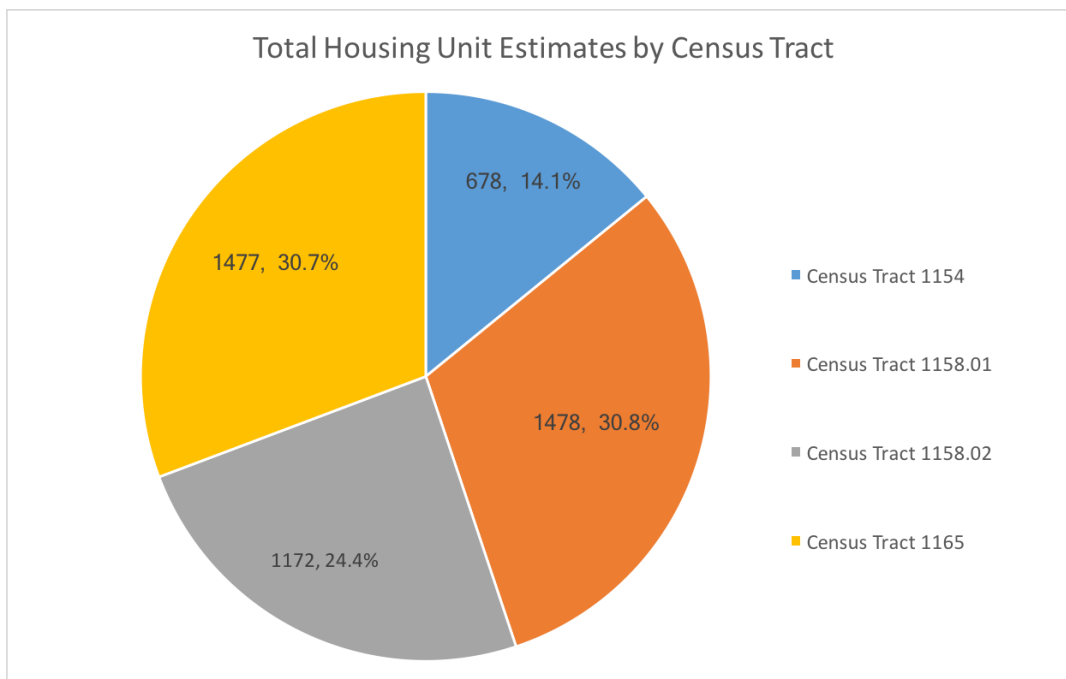
Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05. Note: Unemployment rate calculated as a function of unemployed population as a percent of population in the labor force as defined by the U.S. Census Bureau.

Appendix J: Industry of Employment Along the South Central Light Rail Extension



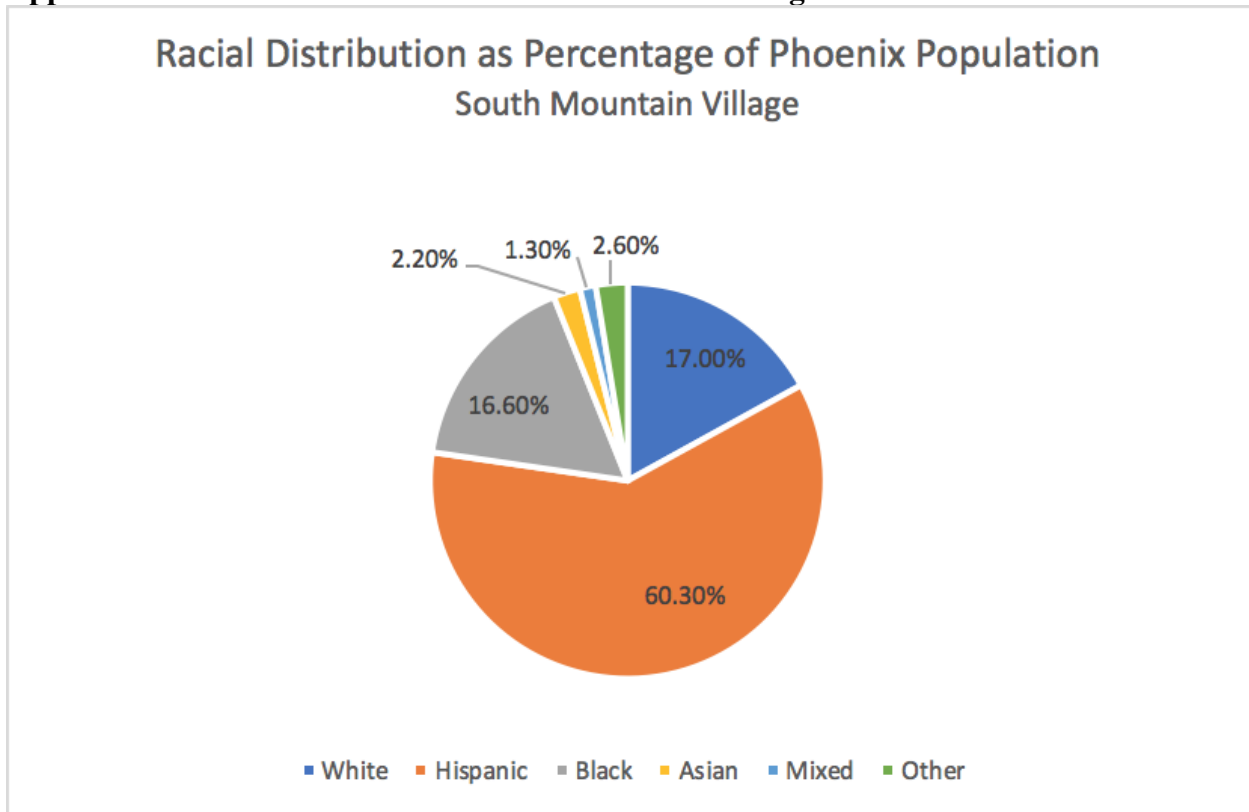
Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Tables DP03 and DP05.

Appendix K: Total Housing Unit Estimate by Census Tract

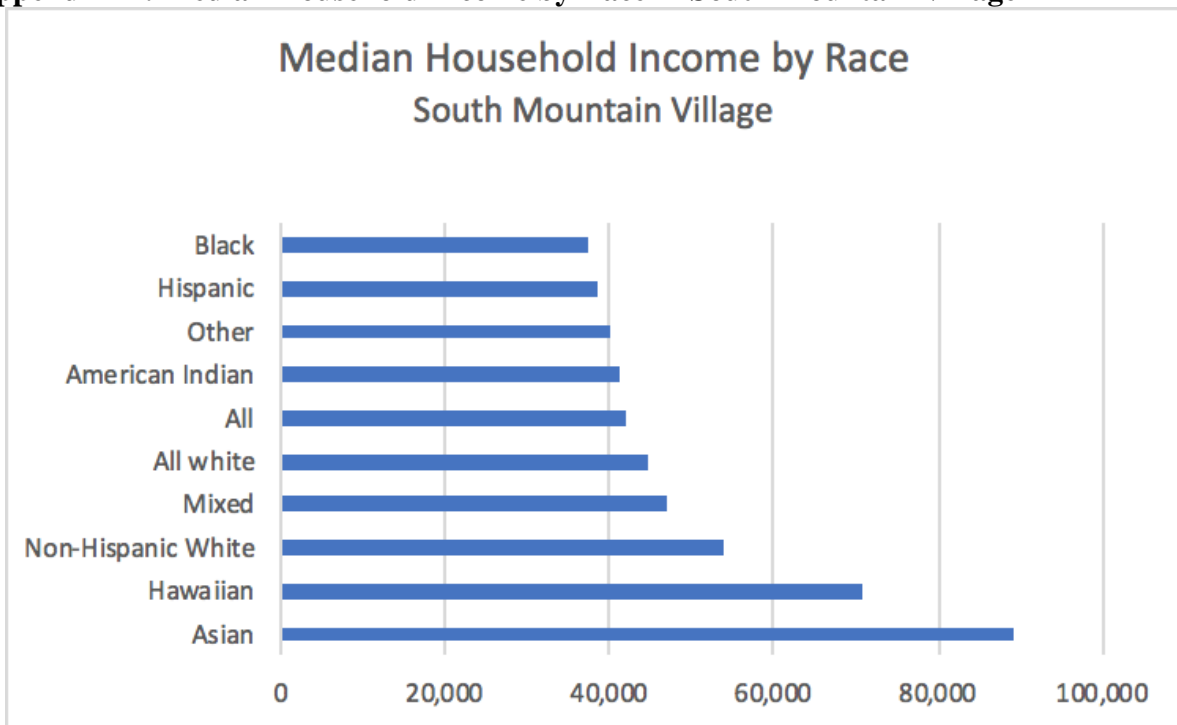


Source: U.S. Census Bureau 2016 ACS 5 year Estimates. Table DP05.

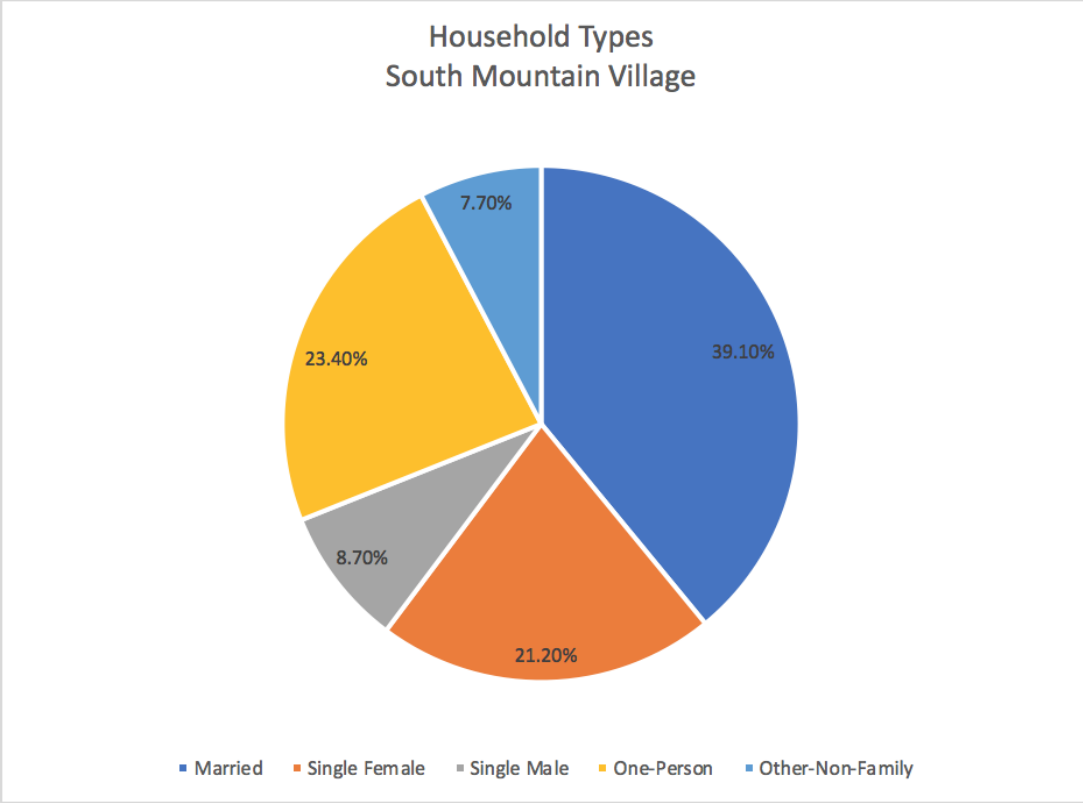
Appendix L: Racial Distribution in South Mountain Village



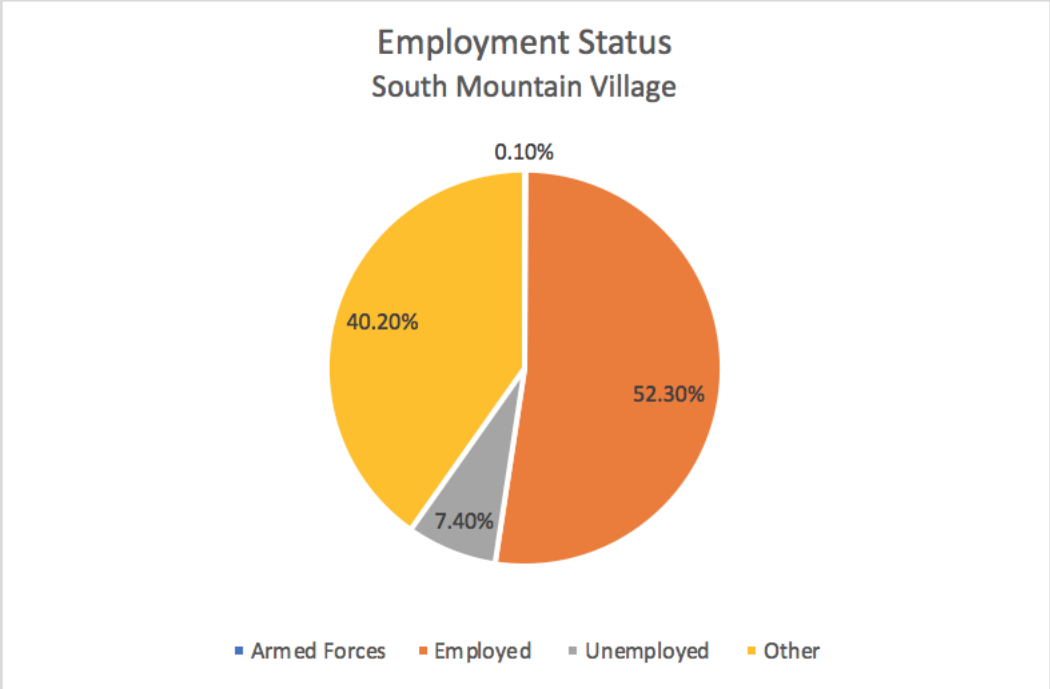
Appendix M: Median Household Income by Race in South Mountain Village



Appendix N: Household Types in South Mountain Village



Appendix O: Employment Status for South Mountain Village



Appendix P: Baseline and Central Light Rail Stop and Surrounding Land characteristics



Source: Google Maps, Maricopa County Department of Public Health

The Baseline and Central Avenue site, the Southern terminus of the LRT South Central Extension, includes nearby facilities such as the Mountain Park Community Health Center. The Western Canal slices through the area. The area retains a mix of residential with more vegetated areas, and shopping and parking lots with asphalt surfaces.

Source: South Central Neighborhoods Transit Health Impact Assessment 2015

Map #6 Walkability of Proposed Light Rail Station at Southern Avenue



Source: Google Maps, Maricopa County Department of Public Health.

The proposed LRT at Southern and Central Avenue would serve the surrounding shopping and strip malls and residential neighborhoods. The landscaped medians north and south of Southern Avenue help somewhat to alleviate the urban heat island effect caused by the asphalt surfaces common in these areas. Nearby amenities include a branch public library and community center.

Appendix Q: Walkability for Planned Light Rail Station at Southern and Central Avenue

Source: South Central Neighborhoods Transit Health Impact Assessment 2015

Map #5 Walkability of Proposed Light Rail Station at Broadway Road



The Broadway and Central Avenue proposed LRT station at the Ed Pastor Transit Center is set amidst large areas of un-vegetated ground covering. This major transit hub serves bus routes 0, 7, 8 and 52.

Appendix R: Walkability for Proposed Broadway and Central Station

Source: South Central Neighborhoods Transit Health Impact Assessment 2015

Source: Google Maps, Maricopa County Department of Public Health.

Appendix S: Site Visit Photos



*(Left) Del Rio Landfill
Redevelopment Site*



*(Left) Vacant lots and
single family homes
prevalent throughout the
study area*



*(Left) Auto-centric
commercial development
and large paved surfaces
are also prevalent
throughout the study
area.*

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