Data, Models, Methods, and Assumptions in the MAG Socioeconomic Projections 2019

Introduction

The purpose of this document is to describe the methodologies, assumptions, analyses, data collection activities, and data sources to be used in developing the base year database, capacity analysis, and housing, population, and employment projections. MAG staff will continue to make use of Arizona's Socioeconomic Modeling Analysis and Reporting Toolbox, hereinafter referred to by its acronym, AZ-SMART. AZ-SMART is a completely customized version of UrbanSim for the MAG region with many additional tools. AZ-SMART requires many data inputs and assumptions.

This document is organized into three major topic areas, each briefly summarized below:

1. **AZ-SMART Base data**
   The development of population and socioeconomic projections requires the collection of a substantial amount of base data. These data sources include the following:
   A. *Census Data Sources*
   B. *MAG Employment Database*
   C. *MAG Residential Completions Database*
   D. *MAG Existing Land Use Database*
   E. *MAG Future Land Use Database*
   F. *MAG Development Projects Database*
   G. *MAG Sub-Regional Geographies*
   H. *Base Population and Housing Variables*
   I. *Base Employment by Land Use and Industrial Sector*
   J. *Other Data Collection Efforts*

2. **AZ-SMART Models and Urban Simulation System**
   The development of population and socioeconomic projections requires a number of models and methods. These include the following:
   A. *Overall Model Process and Objectives*
   B. *AZ-SMART and UrbanSim*
   C. *Overall Methodology for Preparing County and Sub-County Projections*
   D. *County-Level Projections Models*
   E. *Parcel-Level Simulation Model*
   F. *Metropolitan Area Tabulation and Review*
   G. *Transportation Demand Model Feedback*

3. **AZ-SMART Model Assumptions and Methods**
   Additional detail concerning many of AZ-SMART's model methods and assumptions are outlined in this section:
   A. *MAG Socioeconomic Projection Geographies*
   B. *Population and Employment Projections Control Totals*

C. *Methods and Factors for developing housing, households and population projections*
D. *Methods and Factors for developing non-residential built space and employment projections*
E. *Special Population Projections*
F. *AZ-SMART classifications and typologies*

1. AZ-SMART Base data

The development of socioeconomic projections requires the collection and merging of a substantial amount of data from varying sources with differing data quality and resolution. This section begins with a bullet point list of the major datasets that went into the base database. Following this list are sections 1A through 1J that provide additional detail.

- *Population and Housing*: American Community Survey 5 year data (2013-2017), MAG Residential Completions database (see below), County Property Assessment data, MAG/ADOA Annual Population Estimates
- *Group Quarters* (Institutional and Non-institutional): MAG group quarters inventory
- *Detailed Population Characteristics*: American Community Survey (ACS) Public Use Microdata Sample (PUMS) - 5-year data (2013-2017),
- *Employment*: July 1, 2017 MAG Employer Database, County level control totals developed from QCEW/BLS data
- *Residential Completions*: Current through December 2018, submitted and reviewed by MAG member agencies
- *Existing Land Use*: Land use current as of December 2018, reviewed by MAG Population Technical Advisory Committee (POPTAC)
- *Built space*: Maricopa County Assessors data current as of July 2018. Newer downloads from the Assessor will inform the first year of the simulation, 2019.
- *Future Plans*: General Plans current as of December 2018 or later, reviewed by MAG POPTAC
- *Development Data*: data current as of January 2019 or later, reviewed by MAG POPTAC
- *TAZ system*: TAZ2016b supplied by MAG Transportation Division
- Educational institutions: Inventory of schools from Arizona Department of Education and post high school institutions
- *Mobile Home and RV Parks*: Inventory of mobile home and RV parks
- *Airport 2018 and projected enplanements* for Sky Harbor and Williams Gateway airports
- *Retirement Areas*: Age restricted communities reviewed by MAG POPTAC
- *Hotels/Motels/Resorts*: Inventory of hotels/motels

A. Census Data Sources

The following variables were extracted from the 2013-2017 American Community Survey (ACS) and used as a part of the projections base: resident population in households, resident population in group quarters, total housing units, occupied housing units and vacant housing units.

Because the 2013-2017 ACS targets April 1, 2017, it was necessary to adjust the database to July 1, 2017 to provide a mid-year benchmark for the projections series. This adjustment was carried out by adding the sum of housing units constructed from April 2, 2017 through June 30, 2017 and demolitions during the same time period, from the April 1, 2017 housing unit figure. By applying census occupancy rates and persons per occupied household to the July 1, 2017 housing stock, a July 1, 2017 population was derived and subsequently matched to ADOA July 1, 2017 population update by 2017 Census place.

The MAG projections needed a 2017 base of housing units and population by TAZ. To derive this base, MAG added to the April 1, 2017 census housing unit count by TAZ new residential housing units completed, less any demolitions between April 1, 2017 and July 1, 2017. A 2018 base database was also constructed, using the 2017 data and adding to it any incremental updates that were available for all of these datasets by March 2019.

B. MAG Employment Database

Total 2018 employment at the county-level was derived from a control total developed using QCEW data. These data were analyzed and produced by Dr. George Hammond at the University of Arizona's Economic and Business Research Center. Total employment includes unincorporated self-employed as well as wage and salary workers.

Using the 2018 Maricopa County employment control total, 2018 sub-regional employment estimates were prepared. An employer database for Maricopa County and Pinal County employers was purchased from Dunn & Bradstreet/ Harris InfoSource. This database was merged with employers from the Trip Reduction Program, records from public agencies, with records verified via telephone, email and the internet, subjected to quality control measures and reviewed by MAG member agencies.

Each employer was geocoded and employment then summed by land use classification to TAZs. These estimates were then adjusted to the county employment control total for employment not captured in the major employer database based on the underlying land use. This resulted in sub-regional employment estimates, which, in turn, were summed to RAZ and MPA.

C. MAG Residential Building Completions Database

A residential building completion requires a certificate of occupancy for each new residential unit. Since April 1990, MAG has collected residential building completions by unit type from MAG member agencies. The four unit types are single family, condo/townhouse, apartment and mobile home.

After initial collection efforts, the number of residential completions are summed by unit type and forwarded to MAG member agencies for review and verification. Adjustments to the total residential completions by unit type require the submittal of documentation. Each completion is also geocoded, enabling MAG to aggregate new development by MAG geography. Residential completions to December 31, 2018 were used in calculating the base for the 2019 projections.

D. MAG Existing Land Use Database

The Existing Land Use database identifies the current land use pattern in the urban area. MAG maintains more than 100 classifications of land use, which were established by MAG in concert with its member agencies. This table of MAG land use codes is updated by MAG staff periodically and approved by POPTAC members.

The Existing Land Use database was created by MAG staff based on an analysis of the Maricopa County Assessor parcels, aerial photo interpretation, Arizona State Land Department data, MAG databases and input from MAG member agencies, and then circulated to the agencies for review and verification. Changes were made based on comments provided.

The Existing Land Use dataset is important to the projections process because it establishes areas that have already been developed or are not suitable for further development. The developed areas become ineligible for the allocation of population and employment growth, except where the area is planned for redevelopment. Non-developable areas include open space or environmentally sensitive lands, or areas where the relief makes construction infeasible. See Figure 1 below for a map view of our existing land use dataset.

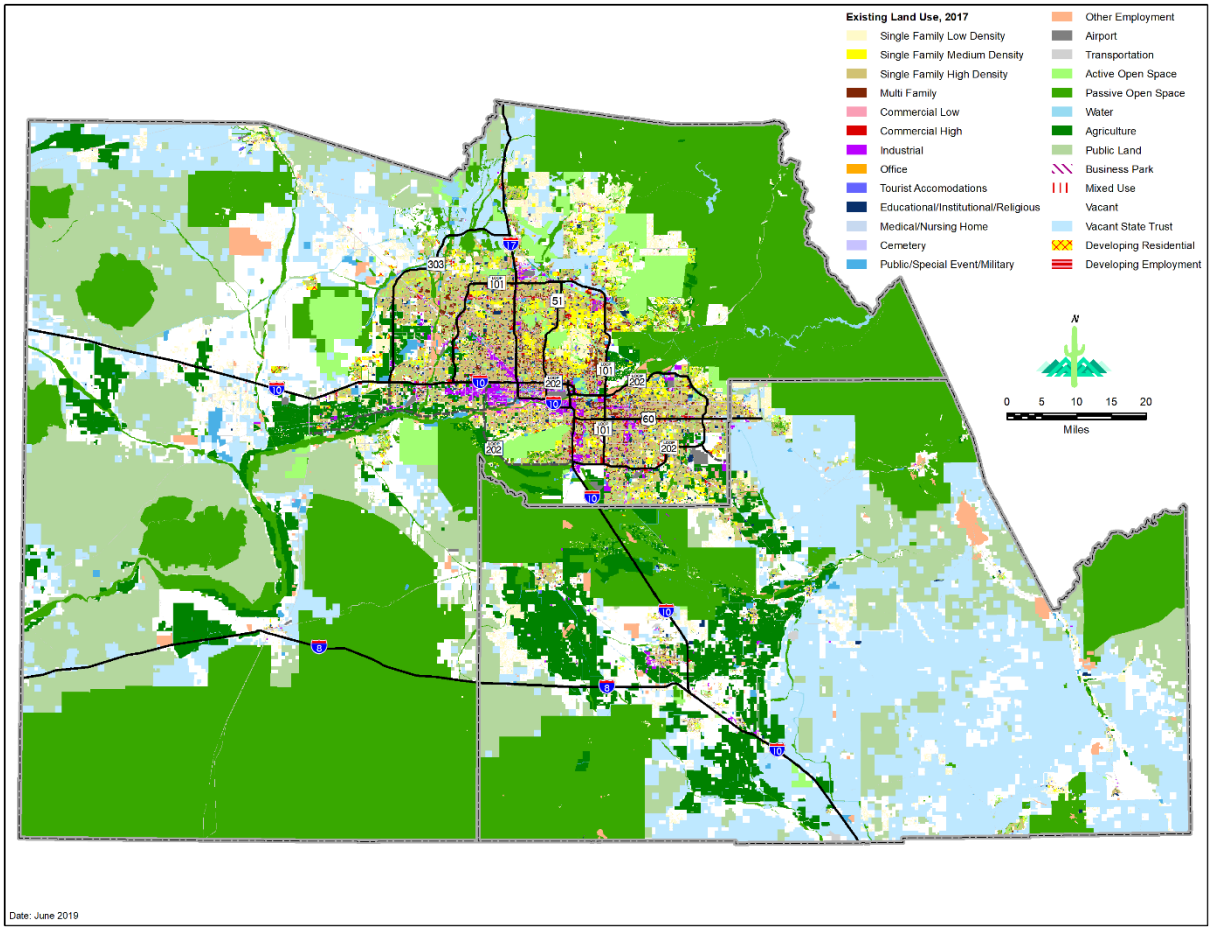

Figure 1 - Existing Land Use Dataset

E. MAG Future Land Use Database

The Future Land Use database is based on the general plans of MAG member agencies and identifies both the type of development that is anticipated to occur in the future and the density of that development. For example, rural residential land use allows for up to one unit per acre.

In those areas designated rural residential, a maximum is established so that the projections model does not exceed the one unit per acre density authorized.

The Future Land Use database also uses the standard MAG land use categories that allows for a direct comparison between existing and planned land use. The difference between the existing and planned land use databases helps determine where development may take place.

MAG tracks general plan land use data for all member agencies. Member agency land use codes are translated into a common region-wide land use category system through a lookup table. The lookup table tracks minimum, target, and maximum development densities for both dwelling units and employment land uses. Land use lookup values can be modified through comments by MAG member agencies. See Figure 2 for a map view of the future land use dataset.

- Selected attributes in the General Plan Land Use dataset are
  - *MPA Land Use Code* – Land use category created by jurisdiction
  - *MAG Land Use Code* – MAG land use categories creating a common coding system for the region
  - *Density Range* – Derived from general plan descriptions.
    - *Minimum* – Least dense development allowed by land use
    - *Target* – Expected development density by land use
    - *Maximum* – Most dense development allowed by land use
  - *Mixed Use Split* – Further definition of mixed use; defines mixed use as percentages of single land use types. For example, Business Park mixed use could be 70% industrial and 30% office. See more information on mixed-use areas in the next section.

Notes on Mixed Use Areas

- The MAG projections are consistent with member agency general plans and planned area developments.
- Many plans have areas defined as multiple or mixed use areas that can generate various types and densities of housing or employment.
- In order to use these designations in the current AZ-SMART modeling system, the multiple use categories must ultimately be converted to one or more of the standard land use categories.
- The MAG socioeconomic models have been enhanced to accommodate such multiple use categories. The models are flexible enough to allow for each individual area to have different proportions of standard land use categories.
- In many cases, MAG member agencies have provided the multiple use categories and splits. In some cases, MAG has estimated the multiple use categories based on descriptions in the general plan or used default multiple use categories. In these cases we reviewed the assumptions with relevant Member Agency staff.
- Default categories are consistent with past local multiple use development but can be modified, area by area, with Member Agency input and feedback.

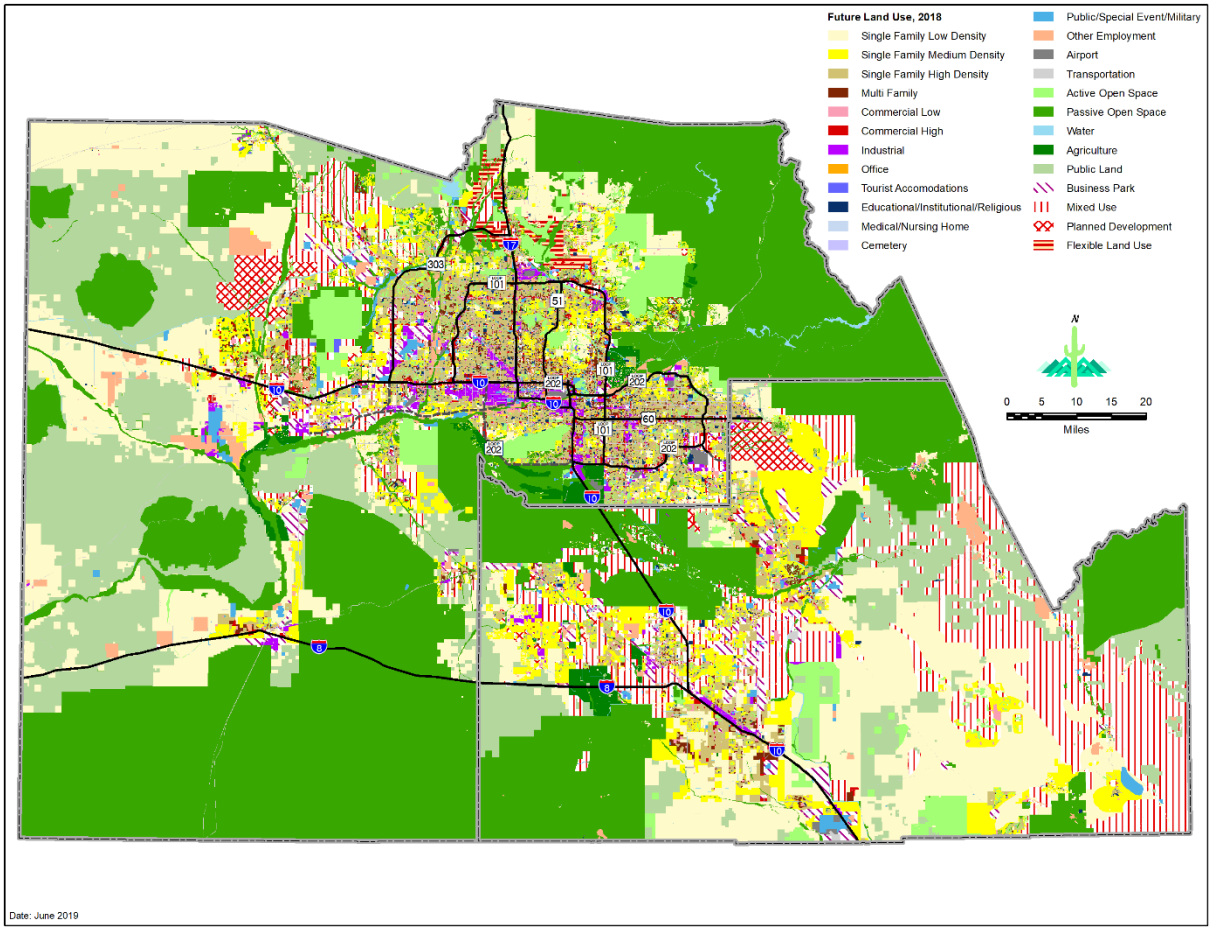

Figure 2 - Future Land Use Dataset

F. MAG Development Projects Database

The Developments database was developed in conjunction with MAG member agencies. Information is collected on residential and non-residential developments including number of units or square footage by land use parcel. An estimated start date for the development is also determined at the same time. Member agencies review the Developments database regularly for completeness and accuracy. The Developments database includes redevelopment and age restricted projects as well. See Figure 3 for a map view of the developments dataset.

- Major Attributes in the Developments database are
  - *MAG Land Use Code* - MAG land use typology creating common coding system for region
  - *Age Restricted Project Flag* – Denotes a development restricted to people age 55+
  - *Redevelopment Project Flag* – Denotes a project that will replace existing development
  - *Development Status* – Defines how close a project is to completion
    - *Conceptual* – Project has not started jurisdiction review
    - *Anticipated* – Project is going through jurisdiction review
    - *Final Plat* – Project has been approved by jurisdiction. This category also includes non-residential site plans.

- *Active* – Project is under construction

- *Start Year* – Estimated year project will start construction
- *End Year* – Estimated year project will be completed
- *Total Units* – Amount of units to be built in project
- *Mixed Use Split* – Further definition of mixed use; defines mixed use as percentages of single land use types. For example, Business Park mixed use could be 70% industrial and 30% office.

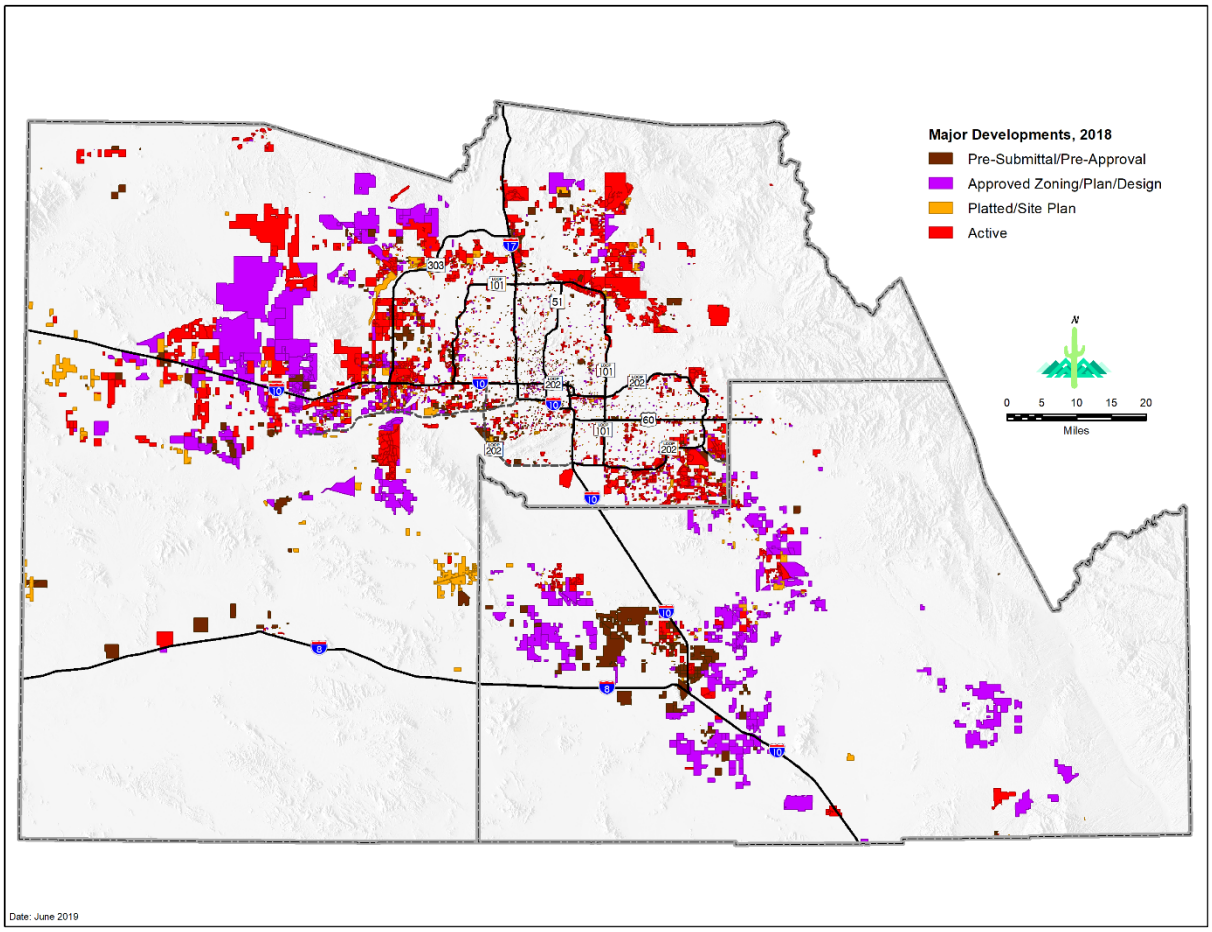

Figure 3 - Development Projected Dataset

G. MAG Sub-regional Geographies

Maricopa County is subdivided into 29 municipal planning areas, 239 regional analysis zones and 3348 traffic analysis zones. MPAs include the corporate limits of a municipality plus any adjacent areas that are anticipated to become a part of those corporate limits in the future. RAZs are subunits of MPAs. RAZs are further divided into TAZs. Their boundaries are defined using major streets and landmarks. In addition, MAG also includes Pinal County and parts of Yavapai and Gila Counties in its transportation modeling area, as transportation needs are influenced by the people living and working in Pinal, Yavapai, and Gila Counties. See Figure 4 for a map that reflects the various geographies.

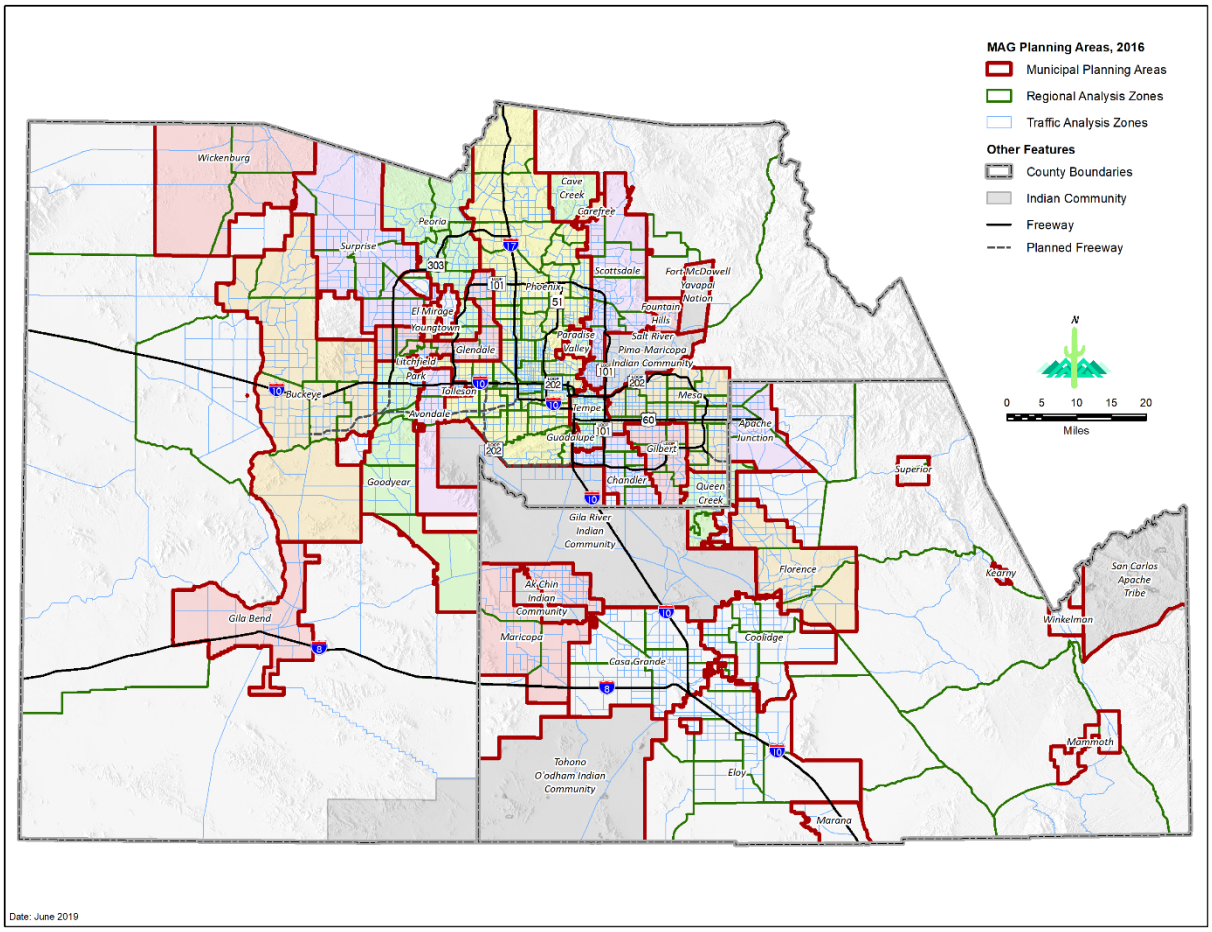

Figure 4 - MAG Planning Geographies

H. Base Population and Housing Variables

AZ-SMART and MAG transportation models require a July 1, 2018 base population, housing, and household total by TAZ2019 along with a detailed synthesized population and housing dataset from which to begin the modeling process.

The following data were used to produce the base July 1, 2018 population and housing variables:

- ACS 2013-2017 data by block, block group, tract, place and county for April 1, 2017 housing units by type, occupied housing units by type, population, households, and group quarters population.
- American Community Survey (ACS) 2013-2017 household and person level characteristics by 2010 Census block group.
- Arizona Department of Administration July 1, 2018 Population Update by Census 2010 place approved by MAG Regional Council.

- MAG Built Space database developed by combining and cross checking data from the Maricopa County Assessor's Office database, US Census Bureau Housing Data, MAG's Residential Completions database, and MAG's Major Group Quarters, Apartment, and Mobile Home/RV Park database.

All data sources are developed and maintained for July 1, 2017, but it is necessary to adjust and reconcile different data sources. MAG staff utilizes to use the following methodology to allocate and reconcile the totals to the TAZ2019 geography:

- The MAG housing inventory is reviewed and adjusted to match ACS 2013-2017 dwelling unit counts at the census block group geography. This review was done in conjunction with the Maricopa County Assessor's data.
- MAG staff utilized UrbanSim's built in micro-population synthesizer called SynthPop (https://github.com/UDST/synthpop). SynthPop is used to synthesize individually linked household and person records from the census Public Use Microdata Sample (PUMS) sample records to match modified ACS 2013-2017 totals (modification described in the next bullet point) at a specially created geography called "pseudo-block groups." Pseudo-block groups are census block groups combined with the census place geography. This allows SynthPop to use household and person level aggregations from the 2013-2017 American Community Survey (ACS) 5-year average at the block group geography while synthesizing the output to match the population at the census place geography simultaneously.
- It is necessary to adjust the aggregations from ACS 2013-2017, which are only available at the census block group level, to both a slightly different geography (pseudo-block group) and timeframe (July 1, 2017). The totals will be updated proportionally based on a ratio of total households and population from April 1, 2017 to July 1, 2017 at the block group geography.
- Once the ACS 2013-2017 totals are adjusted for both space and time, SynthPop can produce individual household and person records at the pseudo-block group geography. This data is then input into AZ-SMART to match the individual household and person records to the MAG housing inventory at the Assessor Parcel geography. Households and persons are matched by comparing and ranking attributes from the PUMS record (e.g. dwelling unit size, household income, etc.) to similar attributes obtained from the MAG housing inventory (e.g. dwelling unit size, dwelling unit value per square foot, etc.). The end result of this process is a very detailed parcel level database of land, built space, and individual households and person records matching census totals. While the data are very detailed, it is a synthetic or hypothetical representation of real households that reflects their characteristics.
- The resulting database is then aggregated to the TAZ2019 geography for review by POPTAC members.

Another segment of the base population that needs to be accounted for is group quarters population. Group quarter populations are split into five categories based on the living facilities: dorms, prisons, nursing homes, military, and other. It is proposed to use the following methodology to estimate the control totals and allocate to the parcel level database:

- Military totals are obtained and the totals confirmed by directly contacting the individual agencies (e.g. Luke AFB).
- The allocation will begin by comparing the MAG Major group quarters inventory with the MAG Built Space database. New built space records are added to the built space inventory as needed to accommodate group quarters population.

- When the ACS 2013-2017 block group contains group quarters population, and there is one or more built space records of group quarters type to accommodate the population, the group quarters population is assigned there.
- When the ACS 2013-2017 indicates there is group quarters population in a block group where the built space inventory does not have an appropriate record for allocation, allocate the total to vacant housing units from the housing inventory. It is expected that these records indicate the presence of small group homes.
- The resulting database of group quarters at the parcel level is then aggregated to the 2016b TAZ geography.

I. Base Employment by Land Use and Industrial Sector

The current MAG 4-step transportation model require employment classified by both land use categories, including work-at-home and construction, and North American Industry Classification System (NAICS) sector based categories.

The following data sources were used for the creation of the required employment databases: Bureau of Labor Statistics (BLS) and the Quarterly Census of Employment and Wages (QCEW) annual totals by 3-digit NAICS categories, the MAG Employment database (with spatial locations built from various public and private sources), the Department of Defense Statistical Information Analysis Division for military employment, and the ACS 5-year average (2013-2017) data for unincorporated self-employed (USE) totals.

Detailed analysis of the MAG Employer database against the build space database has indicated a presence of non-site-based (NSB) jobs. These include workers that are not located at one site; examples include temporary workers, and workers involved in construction, landscape, and janitorial services. To develop base July 1, 2018 employment control totals for Maricopa County, it is proposed to make some adjustments to the county employment totals both within NAICS categories and to split some proportion of each NAICS category to include work-at-home (WAH) employment and NSB employment utilizing the following methodology:

- Compare BLS-QCEW and military county totals to the MAG Employer database and adjust to a new county total based on this analysis.
- Allocate USE county total employment to NAICS categories based on estimates provided by a MAG consultant white paper (Applied Economics, 2009).
- In 2009, a MAG consultant conducted an analysis of the employer database by NAICS categories and suggested the proportions of each sector that are work-at-home and non-site-based.
- Re-allocate some larger public employment categories to new NAICS codes to better reflect the purpose of the employment. For instance, move some large State employment (e.g. ASU) to the education category and some local employment (e.g. Maricopa Integrated Health Systems) to the appropriate medical category.
- Estimate WAH and NSB employment totals for the county by NAICS categories by analyzing the MAG Employer database. Employment points falling onto parcels with a residential land use are split into WAH and NSB categories:
    - Up to two employees on a residential land use in the NAICS code as WAH
    - Additional employees beyond two on a residential land use as NSB.

Once an adjusted total employment for Maricopa County by NAICS categories is complete it is next necessary to allocate the totals sub-regionally and convert them to land use-based employment totals. MAG staff proposes to rely upon the MAG Employer, Existing Land Use, and Built Space databases for this spatial allocation and conversion:

- Compute the difference between total employment by category in the MAG employer database and the total employment control totals by category for the county.
- Factor up (or down) this difference in employment by category utilizing the existing MAG Employer database points to match the county level control totals.

After all of the employment by category is assigned to built space records at the parcel level of geography, the jobs must be summed up by land use category and TAZ2019 for review by POPTAC members:

- Generalize MAG's 2017 Existing Land Use database into five categories: Retail, Office, Industrial, Public, and Other.
- Overlay the modified Employer database onto the Generalized Land Use database and compute the total employment by the five land use categories and two additional categories of work-at-home and non-site-based.
- Aggregate the land use based employment totals to the TAZ2019 geography.

J. Other Data Collection Efforts

Other data needed by the modeling process include post high school institutions and enrollment, elementary and secondary school institutions and enrollment, mobile home and recreational vehicle parks and number of residential and non-residential units, current and projected enplanements for Sky Harbor and Phoenix-Mesa Gateway airports, current and projected retirement areas, built space inventories which are parcel level datasets derived from County Assessor master tables for both residential and non-residential buildings, and hotels, motels and resorts and number of beds and employees. The data on recreational vehicle parks, hotels, motels and resorts are used to develop estimates and projections of non-resident population. The MAG Population Technical Advisory Committee (POPTAC) reviewed this information and provided comments.

2. AZ-SMART Models and Urban Simulation System

A. Overall Model Process and Objectives

The primary purpose of the population and socioeconomic projections developed by MAG is for input into the MAG transportation and air quality models. These projections are also used for a wide variety of regional planning programs such as human services, regional development and by MAG member agencies in developing long-range plans.

Some important objectives of the modeling process are to:

- Establish a linkage between transportation, land use and air quality models. A representation of this linkage is depicted in Figure A.
- Incorporate a geographic information system (GIS) into the process for better data sharing and review with member agencies and for maintaining an innovative approach to land use planning.
- Establish a process by which MAG member agencies can contribute their local knowledge into the model results so they are well suited to usage by member agencies.

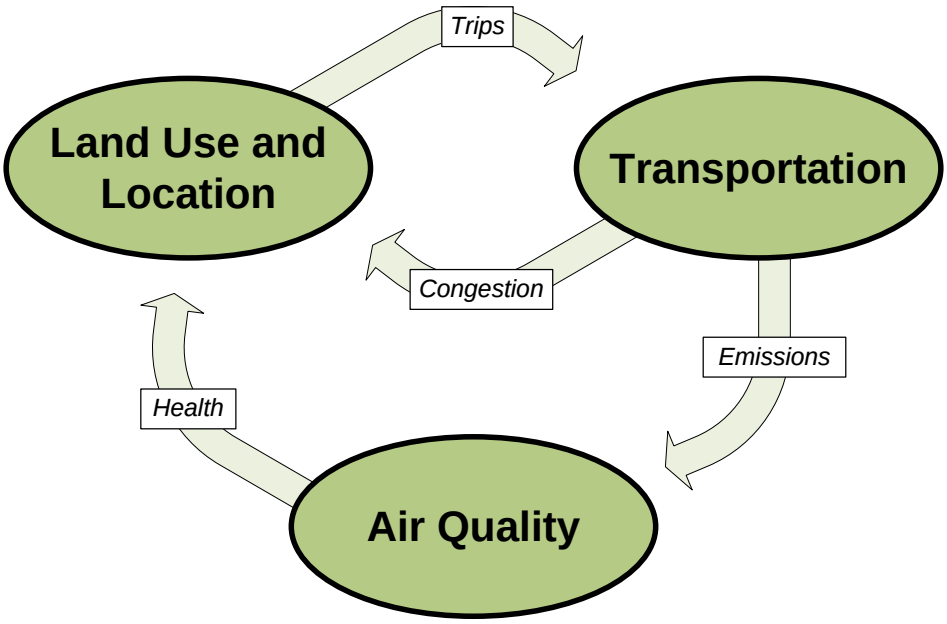

Figure A: Links in the MAG Modeling Process

B. AZ-SMART and UrbanSim

Arizona's Socioeconomic Modeling, Analysis and Reporting Toolbox (AZ-SMART) is a modeling suite that supports socioeconomic activities at MAG, other councils of governments (COGs) and metropolitan planning organizations (MPOs), and elsewhere throughout the state. This modeling suite is a platform on which to build, calibrate, run, and analyze socioeconomic projections and

projection models. It also seamlessly integrates with other third party models. The UrbanSim model system constitutes the bulk of the third party model used in the system and is described below.

UrbanSim is a software-based urban simulation system for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment. It is intended for use by MPOs, cities, counties, non-governmental organizations, researchers and students interested in exploring the effects of infrastructure and policy choices on community outcomes such as motorized and non-motorized accessibility, housing affordability, greenhouse gas emissions, and the protection of open space and environmentally sensitive habitats. It was developed by Prof. Paul Waddell at the University of Washington. Prof. Waddell is now at the Department of City and Regional Planning at the University of California at Berkeley. UrbanSim is used worldwide and is the most widely used land use model in the United States. It is being used in at least 10 MPOs[1]. Documentation for UrbanSim, its various models and configurations, and numerous scholarly papers can be found at the UrbanSim.com website[2].

C. Overall Methodology for Preparing County and Sub-County Projections

The land use, population, and socioeconomic models are based on a three-tier modeling process as shown in Figure B. The first tier (green box) is a demographic model that is used to produce county control totals. The second tier involves using a parcel-level simulation model to allocate the county control total population and employment to Assessor parcels. The third tier allows for the aggregation of the parcel-level population and employment to Metropolitan Planning Areas (MPAs), Transportation Analysis Zones (TAZs), Regional Analysis Zones (RAZs), or almost any other geography in to which the parcels aggregate. The system draws upon the detailed GIS representation of Assessor parcels in the second tier. This also provides a feedback mechanism whereby MAG staff may review simulation results with interested stakeholders and utilize that feedback to revise the model results.

[1] See http://www.urbansim.com/subscribers (last accessed 6/26/2019)
[2] See http://www.urbansim.com (last accessed 6/26/2019)

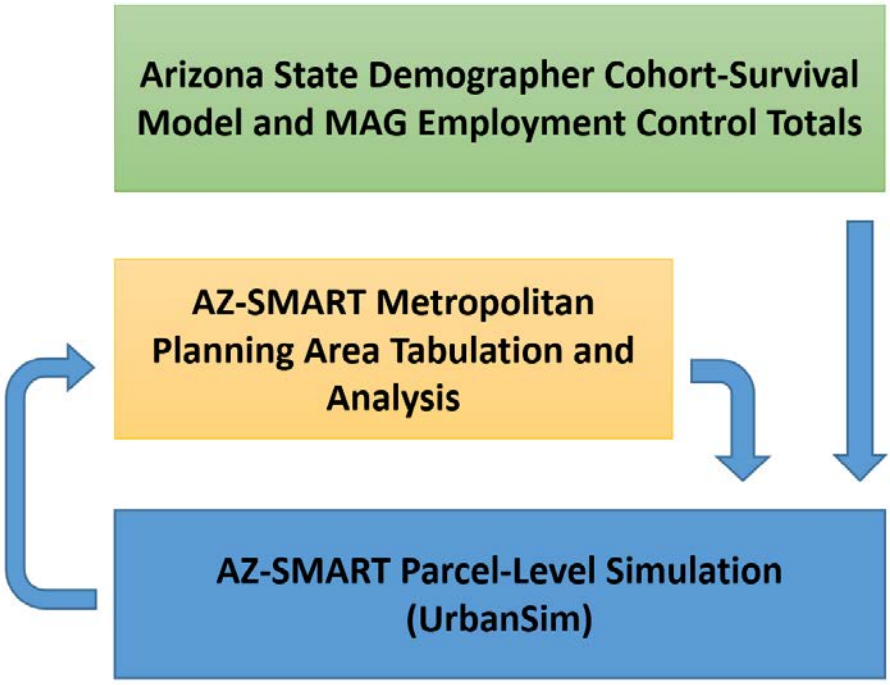

Figure B: Three Tier Modeling Process

D. County-level Projections Models

The first tier in the modeling process is a county-level model. In accordance with Executive Order 2011-04, the preparation of county and state level population projections is the responsibility of the Arizona State Demographer at the Office for Economic Opportunity (OEO). This model is a cohort-survival demographic model projecting births, deaths and net migration in each county annually out to 2055. This model incorporates population by single year of age, sex, 6 race/ethnicity categories, birth rates, death rates, and net migration trends. The model considers short-term economic conditions, but not long-range employment trends. The Arizona State Demographer, using this model, created a population data series, to be consistent with the results of the 2018 population estimate.

The county-level cohort component model was developed with input from the Council for Technical Solutions (CTS) which is made up of representatives from each of the Regional Councils in Arizona, representatives from each of the State universities, representatives from the Department of Health Services (DHS) and the Arizona Department of Transportation (ADOT), along with demographic experts. CTS evaluated the methods and results of the model. In addition, MAG staff regularly reported the findings of CTS to the POPTAC.

Since the MAG transportation models require employment projections as well as population projections, MAG retained the services of Dr. George Hammond at the University of Arizona's Economic and Business Research Center (EBRC) to produce those data. Dr. Hammond produced a set of annual employment projections by 2-digit NAICS category for both counties separately using his established regional forecasting model at The Forecasting Project within EBRC.

E. Parcel Level Simulation Model

The Parcel Level Simulation Model is designed to allocate population and employment from the county level down to Assessor parcels. This simulation model utilized a customized version of UrbanSim. Once simulation results are allocated to the parcel level, results can be aggregated as necessary to other geographies such as the TAZ. Assessor parcels are a collection of parcels that are slightly modified when necessary to cover the entire county in a GIS based on contiguous land uses while respecting other essential geographies such as TAZs. The Parcel Level Simulation Model is a micro-simulation model that tracks the individual parcels, the built space on those parcels, and the individual "agents" (households and persons, and jobs) that occupy the built space. A more detailed description of the Parcel Level Simulation Model follows; also see Figure C.

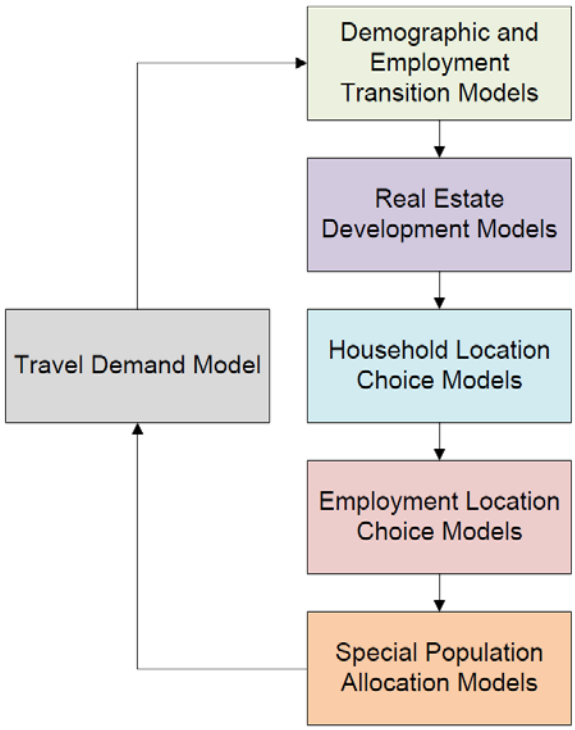

Figure C: Parcel Level Simulation Model Process

Population and employment by industry sector results from the county level control totals feed the Parcel Level Simulation Model. The Demographic and Employment Transition models calculate the difference between the control total for population and jobs and the current simulation year's total of population and jobs by industry sector (for employment). If these models find a difference, they clone or delete agents as necessary until the control totals for the simulation year are met. Any new agents are assigned a status of "unplaced." Unplaced agents are placed later in the simulation year by the location choice models.

The next step in the simulation process is to model real estate market demand and supply. Demand and supply of new built space is calculated by new, unplaced agents waiting to occupy the space and the current state of vacancy in the region. A target vacancy rate is used to determine when to build new space. This target vacancy rate is intended to represent the long-term market clearing rate of vacancy in the market. If the vacancy rate in the region is below the target vacancy rate, new built space will be constructed until the target is met. If the vacancy rate is above the target, no new space will be built unless there are known active developments in the market area. When locations for new built space are being considered, the location of new construction any given simulation year are constrained by two important datasets: known developments and general plans, both of which are maintained continuously by MAG staff and reviewed annually by member agencies. These datasets are used to estimate how much built space can be constructed on a given parcel, and the earliest simulation year the built space could be constructed from start years given by member agencies. Relative real estate prices per unit are also predicted and utilized in the location decisions.

Once the real estate development models have built new space to match the target vacancy rate, "unplaced" households and jobs are located into the built space according to variables such as location, built space type and size, attributes of other households and jobs, accessibility to jobs and shopping opportunities, etc. The location choice models are specified as multinomial logit models, and are stratified into numerous different equations depending on the type of the agent. This allows different factors to influence the location of, for example, retail jobs vs. industrial jobs. The household location choice models are stratified by household income level, while the employment location choice models are stratified by industry sectors (primarily 2-digit NAICS).

After all agents have been located into built space, the simulation runs several additional models to handle special population types that do not necessarily follow market based development patterns. "Population following" employment such as public jobs (e.g. schools, public administration), non-site-based jobs (e.g. construction workers, landscape workers), transient population (population present for less than two weeks such as hotel visitors), group quarters population (e.g. prison, nursing homes), and seasonal population (defined as population present for greater than two weeks but less than six months) are all examples of special populations handled by these models. These models allocate control totals to built-space or land based on a weighting scheme specific to the population. For instance, transient populations are allocated to hotels and dwelling units, and nursing home populations are allocated only to nursing homes.

F. Metropolitan Area Tabulation and Review

For the third tier of the modeling process, data results from the parcel level are aggregated as necessary for review. In this model system almost any geography may be used, however, Metropolitan Planning Areas (MPAs) and Transportation Analysis Zones (TAZs) are the most common. It does this primarily using a point-in-polygon type operation whereby the centroid of parcels are considered to be 100% inside of a single upper-level geography.

At this level, the model results are analyzed and evaluated by stakeholders. Stakeholders include MAG Member Agencies and internal MAG staff (staff experts in MAG's Transportation and

Environmental Divisions). The results from the parcel level simulation model are analyzed and evaluated for consistency and reasonableness using known short-term and expected long-term trends in real estate development, vacancy rates, and other market conditions. MAG Member Agencies provide a critical role in this review level by providing feedback from City staff who are well versed in the local and expected conditions in their respective areas. MAG modeling staff are able to take this feedback and utilize it as input to fuel subsequent AZ-SMART model runs to refine the results to match expected conditions on the ground.

G. Travel Demand Model Feedback

Representing the interaction between land use and transportation is an important part of the projections process. To represent this interaction, results from this model were fed to a travel demand model as inputs. A full set of socioeconomic data from UrbanSim was fed to the MAG Regional Travel Demand Model at the TAZ level of geography, including but not limited to total population, total households, dwelling units by type (single and multi-family), households by income quintile, total jobs and jobs by land use type, and special population variables.

Outputs from the travel demand model, in the form of travel time "skims," are taken from the travel demand model and fed back into the next year of the Parcel Level Simulation Model. These skims take the form of TAZ to TAZ travel time matrices by time of day and mode type. Although many variables were provided in these travel time skims, not all proved to be statistically significant to the simulation's location choice models. Examples of accessibility variables include, but are not limited to, the natural log of the number of retail jobs within 20 minutes travel time in the off-peak single occupant vehicle mode, population within 30 minutes travel time in the transit combined mode, the number of jobs within 45 minutes travel time in the transit combined mode, and the population with a bachelor's degree or higher within 15 minutes. Other non-travel time-related variables were also found to be significant in the location choice models. Examples include the straight line distance to the Phoenix CBD, a Boolean variable for whether or not a building is within a quarter mile of a light rail stop (current or future), and Boolean variables for whether or not a building is within a quarter mile of a freeway. Additional details of the specific models, their coefficients, and other diagnostic information is available.

In addition, due to the time that the travel demand model takes to simulate, the travel demand model is not run for every simulation year. The travel model was run based on professional judgement from our travel modelers on staff at MAG, consultants, and finally input from member agencies. The years for which the travel model is run correspond to major changes in the travel network and/or the passing of a certain number of years.

3. AZ-SMART Model Assumptions and Methods

A. MAG Socioeconomic Projection Geographies

- Maricopa County is subdivided into 29 municipal planning areas (MPAs), 239 regional analysis zones (RAZs), 3348 traffic analysis zones (TAZs).
- The RAZ and TAZ geographies may be modified through comments by MAG member agencies and by MAG transportation planning/modeling staff.
- Each municipality has its own MPA, which delineates the area of planning concern for each jurisdiction. The following process is followed to define MPA boundaries:
    - Prior to the development of a new set of socioeconomic projections, MAG reviews the MPA boundaries with each member agency through the MAG POPTAC. Maps are distributed showing the MPA boundaries from the last set of projections and input is requested.
    - Any area that has been annexed by a jurisdiction that falls outside the current MPA is automatically added to the MPA. Areas that have been de-annexed are removed.
    - Where a jurisdiction requests a change to its MPA, MAG sets up a meeting with the parties involved. Normally this meeting would include the jurisdiction requesting the MPA boundary enlargement, other affected member agencies, if involved, and possibly adjoining jurisdictions. The County is always invited to participate.
    - If there are no objections from the other entities involved, the change to the MPA is made.
    - If there are objections to the expansion of the MPA, and no consensus compromise is reached by the jurisdictions, MAG will leave the MPA boundaries as they existed in the last set of projections. Ultimately, whichever jurisdiction annexes the territory, will have it included in its MPA.
    - A jurisdiction is responsible for reviewing and providing input on land use, base data, surveys, assumptions and draft socioeconomic projections for the entire MPA.
- TAZs are required for transportation planning with input from the MAG POPTAC.
- TAZs are modified as expected growth in a 30-year horizon expands geographically or densities in existing TAZs warrant TAZ splits.
- TAZ boundaries are delineated utilizing existing and future highway corridors, transit networks, major arterials, waterways/canals, and other natural features such as mountains.
- TAZs and RAZs fall completely within only one MPA, as TAZs add up to RAZs, and RAZs add up to MPAs.

B. Population and Employment Projections Control Totals

A. Population

- The Arizona State Demographer created a cohort-component population projection model to be consistent with the results of the 2018 Population Estimate. The cohort-component model was created with input from the Council for Technical Solutions.
- MAG develops its sub-regional resident population projections to be consistent with population control totals for Maricopa County developed by the Arizona State Demographer.

B. Employment

- The Arizona Department of Administration (ADOA) Office of Employment and Population Statistics (EPS) does not produce county level long-term employment forecasts, therefore it is necessary to obtain employment projections from another source.
- In the past, MAG staff, along with a consultant (Jeff Tayman from University of California, San Diego), conducted an analysis of commercial long-term socioeconomic projections for purchase. We found that such forecasts need considerable adjustment to be consistent with what we have in our base year database.
- In lieu of purchasing and adjusting a commercial forecast, we retained the services of Dr. George Hammond at the University of Arizona's Economic and Business Research Center (EBRC). There Dr. Hammond runs The Forecasting Project where he maintains metro area and statewide forecasting models.
- Dr. Hammond used the results of the State Demographer's cohort-component model to inform the population side of his model. This produced an employment forecast that is consistent with the population.
- The employment forecast is annual out to 2055 by 2-digit NAICS categories.

C. Methods and Factors for Developing Projections of Housing

A. Residential Density

- In developing TAZ population projections, the MAG socioeconomic models project residential dwelling units from parcels identified for residential uses in the general plans or areas anticipated to be residential in the Developments database. Households and population by TAZ are subsequently calculated from the dwelling unit projections.
- Three general plan residential density figures (dwelling units/acre) have been collected from the member agencies. These include the minimum, maximum and target residential density anticipated for each residential land use type in the general plan. The models use target density as the base for new residential growth. The maximum density set by the MPA caps the residential density. These densities may be changed polygon-by-polygon by the member agencies if desired.
- Areas covered by the Developments database have the number of dwelling units being built/planned and thus do not need to use the densities identified in the general plan.

B. Gross to Net Density

AZ-SMART residential modeling assumes the use of net residential density. Net density means that land area has been taken out for transportation, right of way, and open space areas as part of the density given in the general plan document. An analysis of gross acres and net acres by different residential land use types has been conducted. The results are the basis for converting gross residential density to net residential density as needed.

Net Residential Density				
LUCODE	**Land Use**	**Description**	**Gross Acres**	**Net Acres**
110	Rural Residential	<= 1/5 du per acre	50	50
120	Estate Residential	1/5 du per acre to 1 du per acre	50	50
130	Large Lot Residential (SF)	1 du per acre to 2 du per acre	50	50
140	Medium Lot Residential (SF)	2-4 du per acre	50	38
150	Small Lot Residential (SF)	4-6 du per acre	50	37.5
160	Very Small Lot Residential (SF)	>6 du per acre (includes mobile home parks)	50	37.5
170	Medium Density Residential (MF)	5-10 du per acre	50	38.5
180	High Density Residential (MF)	10-15 du per acre	50	41
190	Very High Density Residential (MF)	> 15 du per acre	50	36

C. Persons per Household (PPHH)

Persons per household assumptions for buildout are derived from the ACS 2013-2017 by dividing the population in households by the number of occupied housing units. Total housing units, total occupied housing units and population in households was identified by census block. These variables were then allocated to the TAZ2019 geography using the data from Census 2010. PPHH is derived at the lowest level of geography possible then refined at the TAZ2019 level. This refinement is important since figures resulting from a sparsely developed TAZ may not adequately reflect future trends in the TAZ. The PPHH refinement is as follows:

- For TAZs where existing development in 2010 is less than 50% of the buildout number, PPHH from the RAZ will be used instead.
- Similarly, for RAZs where the existing development in 2010 is less than 50% of the buildout number, PPHH from the MPA will be used.
- A maximum PPHH at buildout will be set at 5.0.

D. Vacancy Rates

Vacancy rates are used in the simulation model. An analysis of vacancy rates by census place was conducted and used to make a determination about the long-term or "structural" vacancy rate due to the normal migration and relocation of population within the region. This structural vacancy rate (roughly 5% for single family and ranging up to approximately 9% for larger multi-family developments) is used as a target that drives new residential development in the simulation model. For buildout analysis, the vacancy rates were calculated at the census block geography for single family (SF) and multi-family (MF) residential types. A census block to TAZ2019 lookup file was created to re-calculate the vacancy rates by TAZ2019. Vacancy rates were then applied to buildout dwelling units as follows:

- For TAZs where existing development in 2018 is less than 50% of the buildout number, use a 5% vacancy rate for this TAZ. The reasoning is that at the present time we do not know how this TAZ is going to look, so we assume a longer-term average vacancy rate of 5%.
- For TAZs where existing development in 2018 is greater than 50% of the buildout number, use the minimum of either 5% or the current vacancy rate minus the

percentage of the current dwelling units (DUs) that are considered seasonal use only (from the 2013-2017 ACS) then adding the percentage seasonal units back to arrive at a final vacancy rate. The reasoning here is that since the TAZ is mostly built out already, we have a good idea of how many seasonal units there will be in the TAZ and we want to maintain that in the calculation of vacancy rate.

F. Age Restricted Communities

- MAG transportation models require TAZs to have identifiers for age-restricted areas.
- A survey of the existing age restricted communities was conducted and a GIS dataset of the communities was created.
- All developments are reviewed with member agencies to identify additional age restricted communities.
- TAZs with fifty percent or more of their residential land area under communities with deed restrictions on age of residents are flagged as age restricted TAZs.
- These age restricted flags are utilized only as an input for the transportation model and do not impact the projection series.

D. Methods and Factors for Developing Projections of Non-Residential Built-Space

A. Employment Density and Floor Area Ratios (FAR)

- FAR represents the ratio of the square footage of the building to the square footage of the parcel of land.
- Employment density represents the floor space required by employees. This is calculated as building floor space per employee.
- The MAG models convert a parcel of land to the square feet of employment space and then to the number of employees on that parcel. This requires an understanding of average employment areas.
- FAR and employment density differ for each non-residential land use type.
- An analysis of employment density ranges by land use type was conducted by a Consultant by analyzing data in the MAG Built Space and the MAG Employer databases. Jobs by land use type were compared to building square footage by land use type.
- An analysis of FAR ranges by land use type was conducted by analyzing data in the MAG built space database by comparing building square footage to parcel square footage by land use type.
- The following tables show the results of the analysis of employment density and FAR.

OFFICE EMPLOYMENT AND DEVELOPMENT BY INDUSTRY

		FAR	Sq.Ft. per Employee
Information			
511	Publishing Industries (except Internet)	0.57	390
512	Motion Picture and Sound Recording Industries	0.37	574
515	Broadcasting (except Internet)	0.36	376
517	Telecommunications	0.30	500
518	Data Processing, Hosting and Related Services	0.34	349
519	Other Information Services	0.08	478
	51 Total	0.29	463
Finance & Insurance			
522	Banking	0.33	429
522	Consumer Lending	0.46	441
522	Other Lending	0.25	388
523	Investments	0.53	588
524	Insurance Carriers and Related Activities	0.55	423
	52 Total	0.42	445
Real Estate and Rental and Leasing			
531	Real Estate Leasing	0.25	520
531	Real Estate Agents	0.37	390
532	Car & Truck Rental	0.08	590
532	Consular Rentals	0.33	623
532	Machinery and Equipment Rental and Leasing	0.13	485
	53 Total	0.19	468

RETAIL EMPLOYMENT AND DEVELOPMENT BY INDUSTRY

		FAR	Sq.Ft. per Employee
Retail			
441	Motor Vehicle and Parts Dealers	0.18	379
441	Recreational Vehicle Dealers	0.10	754
441	Automotive Parts and Accessories Stores	0.26	724
442	Furniture and Home Furnishings Stores	0.31	674
443	Electronics and Appliance Stores	0.31	532
444	Building Material and Garden Equipment and Supplies Dealers	0.24	637
445	Supermarkets and Grocery Stores	0.24	454
445	Other Food and Beverage Stores	0.26	498
446	Health and Personal Care Stores	0.28	562
447	Gasoline Stations	0.10	340
448	Clothing and Clothing Accessories Stores	0.38	615
451	Sporting Goods, Hobby, Book, and Music Stores	0.27	583
452	General Merchandise Stores	0.30	741
452	Warehouse Clubs and Supercenters	0.23	566
452	All Other General Merchandise Stores	0.18	702
453	Miscellaneous Store Retailers	0.32	548
454	Nonstore Retailers	0.22	506
	Retail Total	0.25	561
Restaurants			
722	Food Service Contractors and Caterers	0.23	326
722	Drinking Places (Alcoholic Beverages)	0.27	485
722	Full-Service Restaurants	0.27	471
722	Limited-Service Restaurants	0.24	464
722	Snack and Nonalcoholic Beverage Bars	0.26	485
	Restaurant Total	0.26	463
Hotels		0.37	956

INDUSTRIAL EMPLOYMENT AND DEVELOPMENT BY INDUSTRY

		FAR	Sq.Ft. per Employee
Manufacturing			
311	Food Manufacturing	0.26	460
312	Beverage and Tobacco Product Manufacturing	0.37	761
314-323	Textiles/Wood Products/Printing	0.31	717
324-326	Petroleum/Pharmaceuticals/Plastics	0.28	596
327	Concrete/Concrete Products/Stone	0.08	580
331-332	Steel/Fabricated Metals/Machine Shops	0.30	549
333	Machinery Manufacturing	0.37	308
334	Computer and Electronic Product Manufacturing	0.33	428
335	Electrical Equipment, Appliance, and Component Manufacturing	0.35	697
336	Transportation Equipment Manufacturing	0.13	363
337	Furniture and Related Product Manufacturing	0.37	789
339	Miscellaneous Manufacturing	0.26	520
	Total	0.25	495
Warehouse			
423	Merchant Wholesalers, Durable Goods	0.29	514
424	Merchant Wholesalers, Nondurable Goods	0.32	735
484	General Freight Trucking	0.11	191
493	Warehousing and Storage	0.33	1,625
	Total (W/O Trucking)	0.32	959
Construction			
23	Industrial	0.29	421
23	Office	0.44	336
23	Retail	0.19	300
	Total	0.29	369

B. Non-residential Vacancy Rates

A projection of non-residential vacancy rates by building type is required for the simulation model to develop new non-residential real estate. MAG staff obtained data on the commercial real estate market from the vendor COSTAR. COSTAR data and reports contain longitudinal data going back as far as 2001 on non-residential vacancy rates in the Phoenix Metropolitan Area (which includes parts of Pinal County) and the United States as a whole. COSTAR provides these rates for broad classes of non-residential building types: retail (back to 2007), office (back to 2001),

industrial (back to 2001). The average for each building type in the Phoenix area was compared with the same data at the national level. Where the rates met is where it was assumed that the Phoenix market was similar to the national market, and that rate was used as the long-term structural vacancy rate for the simulation model. The rates are as follows: retail 6.5%, industrial 8%, and office 10.5%.

E. Special Populations Projections

A. Group Quarters

All residents not living in households are classified as living in group quarters. Population in group quarters is a part of the socioeconomic projections required by MAG transportation models. Methods for projecting the different components of population in group quarters (military quarters, prisons and jails, college dormitories, nursing homes, and other group quarters) have been identified by a MAG consultant. The base year group quarters population is based upon the results of the ACS 2013-2017 and the group quarter inventory prepared by MAG staff and reviewed by POPTAC previously.

- Military group quarters population: Military group quarters population is held constant at the current population of Luke Air Force Base at the recommendation of a consultant. MAG staff contacted a Luke Air Force Base representative to confirm the latest population of 927.
- Prison and jail population: Prison and jail population is projected as a percentage of the population in the age cohort of 20-44, increasing slightly throughout the projection horizon. Based on analysis of historical census data by a consultant it is recommended that a slight increase in the factor be applied throughout the projection horizon as follows: the rate will start at 1.4% and rise to 1.8% in 2055 in an annual linear fashion. During the simulation model run, the percentage of the population is calculated, then it is proportionally allocated to existing prison and jail sites in Maricopa County based on the current size of each facility. If a new prison or jail site is included in the simulation as a known development, the model will include that site in the allocation. The simulation model does not predict new prison and jail facilities, however.
- College dormitory population: College dormitory population is calculated as a percentage of the population in the age cohort 18 through 19. This percentage is held at a constant 11% throughout the forecasting horizon of 2055 at the recommendation of a consultant. During the simulation model run, the percentage of the population is calculated; it is then proportionally allocated to existing dormitory sites based on their size. If new dormitory sites are included in a known development in a later simulation year, the model will include those sites in the allocation. The simulation model does not predict new dormitory sites, however.
- Nursing home population: Nursing home population is calculated as a percentage of the population in the age cohort 75 and older. An analysis of historical census data by a consultant indicated a slow but steady downward trend since 1980. The pace of the decline slowed between 2000 and 2010 (0.7 percentage points) compared to the previous decade (3.4 percentage points). The consultant recommended that we trend the 2010 rate downward at a decreasing rate. To this end, the percentage decreases slightly throughout the projection horizon: The rate starts at 3.9% in 2014 and declines in a linear fashion annually to 3.7% in 2055. During the simulation model run, the percentage of the population is calculated, then this total is proportionally allocated to existing nursing home sites based on their size. If new nursing home sites are included in a known development in a later

simulation year, the model will include those sites in the allocation. The simulation model does not predict new nursing home sites, however.

- Other group quarters population: Other group quarters population, such as group homes, is calculated as a percentage of the entire population. At the recommendation of a consultant, the percentage is held at a constant 0.3% throughout the projection horizon of 2055. During the simulation model run, the percentage of the population is calculated, then this total is proportionally allocated to existing other group quarters sites based on their size. If new other group quarters sites are included in a known development in a later simulation year, the model will include those sites in the allocation. The simulation model does not predict new other group quarters sites, however.

B. Airport Originations

Daily airport originations are required as part of the MAG transportation model for the two major airport sites in the region: Sky Harbor Airport in Phoenix, AZ and Phoenix-Mesa Gateway Airport in Mesa, AZ. Projections of flight originations for every five years from 2010 through 2055 were obtained from the respective airports' master plans. Annual flight originations for both airports were calculated from every five-year numbers using a straightforward linear interpolation methodology. The originations are simply assigned to the respective airport location in the simulation model. The simulation model does not predict new airport locations.

C. Seasonal Population

Seasonal population is defined as residents of the area for two weeks to six months and is a part of the socioeconomic projections required by the MAG transportation models. An inventory of mobile home parks and RV parks was created to gather information on location and characteristics of the parks, expansion plans, as well as the number and types of residents during peak and low seasons. Seasonal residents are divided into three categories for projections, namely those residing in single and multiple family housing units (SFMFS), mobile homes (MHS) and RV parks (RVS).

- To calculate base year seasonal households and population by unit type (SFMFS, MHS, RVS), we start with the total units by type from the ACS 2013-2017 (SFMFS and MHS) and use the MAG RV database for RVS. We then apply the seasonal vacancy rate by type from the census to arrive at a total number of seasonal households. Then a constant 1.9 persons per household is assumed to estimate the seasonal population in the base year.
- Using information from the MAG General Plan database, multi-family/single family percentages are calculated for future years. In addition, due to economic conditions, the 2014 vacancy rates are assumed to be too high, so using the recommendation of our consultant, we adjust the overall seasonal and non-seasonal rates down to a more normal 3.9% and 5.5% (respectively) by 2020 using a linear interpolation. These rates are held constant from 2020 to the end of the forecast horizon.
- The vacancy rates and multi-family/single family splits are used to forecast seasonal and non-seasonal units by type in the future simulation years.
- In the future simulation years, seasonal population and households by unit type are estimated from the exogenous forecast of total population, using the above calculated and adjusted vacancy rates by unit type.
- The seasonal population forecast totals by unit type are then proportionally allocated to seasonal units annually in the simulation model.

D. *Transient Population*

Transient population is defined as residents of the area for two weeks or less and is a part of the socioeconomic projections required by the MAG transportation models. To estimate transient population, an inventory of hotels, motels, and resorts was created to gather information on their location, number of rooms, occupancy, expansion plans, and information on new facilities. Current data on visitor statistics and projections were obtained from the Arizona Office of Tourism (http://www.azot.gov/research-and-statistics; Last accessed 6/26/2019) to produce base transient population.

Transient Population is tightly correlated with employment and spending in the Accommodation and Food Services and Leisure and Hospitality sectors of the county economy. A consultant recommended that we base our methodology for generating future control totals on projections of employment. Using data obtained from the Arizona Office of Tourism and projections of employment from Moody's Economy.com, the following factors are used: 18.35 million annual overnight visitors to Maricopa County, staying an average of 4.4 nights, with an average party size of 2.6, with a 62%/38% split between stays in hotels and other locations respectively.

- First, average daily visitors are calculated by dividing annual visitors (18.35 million) by the average daily stay (4.4). This number is then split using the aforementioned percentages to get a hotel and other locations split.
- The 18.35 million annual visitors is increased over time in proportion to the total employment in the aforementioned sectors of the economy, giving us increasing totals for future allocation.
- Then for the future average daily visitors, we apply the same methodology to compute the base year splits by hotels and other locations.
- During the simulation, transient population projections at the county level are proportionally allocated to the hotel, motel, resort, and other sites based on their respective size. If the known developments dataset contains a new hotels, motels, or resorts, the allocation model will take those new sites into account. The simulation model does not predict new transient population sites.

E. *Schools*

School enrollment projections are a component of socioeconomic projections required by the MAG transportation models. Enrollments are projected for three grade levels: Kindergarten through 8th grade, 9th through 12th grade, and post-secondary education. The resulting enrollment projections serve as a primary input for forecasting site-based education employment.

The enrollment projections are based on a series on school site inventories developed by MAG staff. The *K-12 site inventory* details the location, current enrollment and student capacities of existing school sites, and classifies them by their type (public, private or charter) and grade-level (primary, middle, high). The K-12 site inventory was compiled by geo-referencing charter and public school enrollment data from the Arizona Department of Education and geo-referencing private school enrollment data from internet resources. The *post-secondary inventory* details the locations and current enrollments of post high school institutions and classifies them into one of two groups: public schools, which include universities and community colleges, and private

schools, which include traditional as well as trade/career schools. This dataset was developed from a phone and internet survey of post-secondary education providers to gather information on current enrollment and expansion plans. The *future sites inventory* contains potential school sites that new enrollments may be allocated to in future years. For future K-12 sites, the timing of the new site is dependent upon changes in enrollment within the school district. For post-secondary sites, the timing is defined in the inventory. The inventory was compiled from various sources, including member agency comments, Maricopa County land ownership data, and the MAG planned developments dataset.

Enrollment participation rates by age cohort, household income quintile, school type and school level were developed by a MAG consultant using data from the American Community Survey (ACS) and Arizona Department of Education. These rates are applied to socioeconomic outputs from AZ-SMART to generate the enrollment projections for each school type and level. For K-12, school sites are organized into districts and the enrollment in each district is allocated to school sites on the basis of their capacity. When districts exceed their capacity, new schools are generated. For post-secondary sites, students are allocated on the basis of their previous enrollment. New sites are generated as prescribed by the future sites inventory.

F. AZ-SMART Classifications and Typologies

AZ-SMART requires a number of classification types for data. These AZ-SMART classifications are utilized internally for simulation purposes only. Classifications can be modified through comments by MAG member agencies.

A. Building Types

AZ-SMART requires a classification of building types. The building types are used to identify the different types of built space that are tracked in the model. The type of space also has some bearing on what type of occupants may locate there. For instance, industrial types of employment may be restricted to appropriate building types in the simulation. The following is a list of the building types for use in the model.

- Single Family Residential
- Multi-Family Residential
- Mobile Home Residential
- Retail
- Mini Storage
- Warehouse
- Industrial
- Office
- Medical
- Hotel
- Civic
- Education
- Group Quarters

- Public – Federal and State
- Public – Local
- Agriculture
- Transportation
- Other/Open Space

B. Employment Sectors

AZ-SMART requires a classification of NAICS employment sectors. The following is a table of the employment sectors for use in the model.

AZ-SMART Employment Sectors

Employment Sector	NAICS Code
Agriculture, Forestry, Fishing and Hunting	11
Mining, Quarrying, and Oil and Gas Extraction	21
Utilities	22
Construction	23
Manufacturing	31-33
Wholesale Trade	42
Retail Trade	44-45
Transportation and Warehousing	48-49
Information	51
Finance and Insurance	52
Real Estate and Rental and Leasing	53
Professional, Scientific, and Technical Services	54
Management of Companies and Enterprises	55
Administrative and Support and Waste Management and Remediation Services	56
Educational Services	61
Health Care and Social Assistance	62
Arts, Entertainment, and Recreation	71
Accommodation	721
Food Services and Drinking Places	722
Other Services (except Public Administration)	81
Public - Federal and State	Part of 92
Public - Local	Part of 92

Source: US Census Bureau 2007 NAICS