MTP Connections 2040 Socioeconomic Forecast for the MRCOG Region

By County and Data Analysis Subzone (DASZ): Methodology Document, May 2020

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Introduction

Every four years, the Mid-Region Metropolitan Planning Organization (MRMPO) is required to produce a transportation plan that looks forward at least 20 years and identifies both short and long range strategies and actions that will lead to the development of an integrated multi-modal transportation system. In support of this process, the MPO also produces a long-range socioeconomic forecast that incorporates the latest available data and assumptions for population, land use, and employment. The 2040 Socioeconomic Forecast was developed based on the approved roadway and transit network in the Connections 2040 Metropolitan Transportation Plan. Both the socioeconomic forecast and the short and long range transportation projects were approved as part of the 2040 Metropolitan Transportation Plan (MTP) by the Metropolitan Transportation Board (MTB) in April 2020.

The primary purpose of MRMPO's socioeconomic forecast is to identify the most likely future trip origins (homes) and destinations (work, shopping, etc.) in order to anticipate future infrastructure needs and prioritize transportation investments accordingly. These forecasts are available to public, private and governmental entities for their own use. They are used by transportation planners and decision-makers as they perform project planning and develop local land use and transportation policy. They are also used to support other planning endeavors pertaining to issues such as housing, public health, and economic development. Since the socioeconomic forecasts have broader application than the MTP, they are developed for the whole region as illustrated in Map 1, rather than just the metropolitan area.

Elements of the Forecast

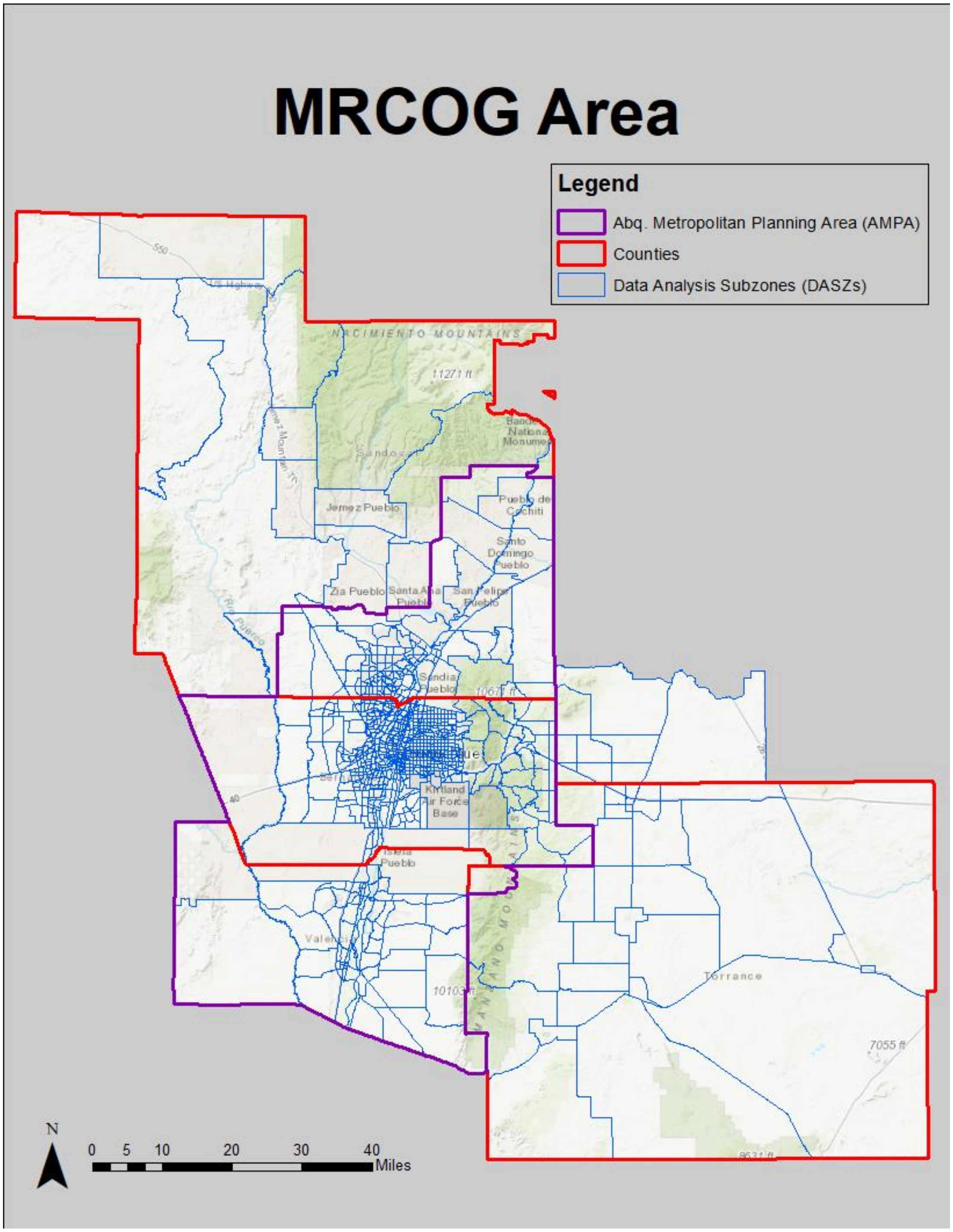
The socioeconomic forecast consists of several variables that are necessary to project future travel demand in the region.

Figure 1: MRCOG Socioeconomic Variables

MRCOG Socioeconomic Variables		
Population	*Housing*	*Employment*
Total Population	Housing Units	Total Employment
Household Population	Single Family Housing Units	Basic Employment
Households	Multifamily Housing Units	Retail Employment
		Service Employment

The forecast is presented within this document at three distinct geographic levels: region, county, and data analysis sub-zone (DASZ). The MRCOG region encompasses the four counties of Bernalillo, Sandoval, Torrance and Valencia as well as the southern portion of Santa Fe County. The counties refer to the aforementioned whole and partial counties that are contained within the region. Lastly, DASZs are a small geography developed by transportation planners and used for the travel demand model. DASZ's are designed to be areas that are somewhat homogenous in terms of their socioeconomic characteristics and are bounded by major roadways and other infrastructure and natural boundaries as well as county lines. DASZ boundaries do not conform to municipal boundaries or school districts due to frequent shifts in these boundaries. As such, forecasts for such areas require additional customization. There are 926 DASZs in the MRCOG region. Map 1 illustrates the MRCOG region, the county boundaries, and the DASZs.

Map 1: MRCOG Planning Area



How to Use the Forecast

MRMPO begins with existing resources that produce projections at the county level and adds value to them by forecasting where that growth will occur at a sub-county level.

MRMPO's forecasts are the result of a set of current policies, locally developed assumptions, and the most up-to-date data available at one point in time. Changes to any one of these factors will inevitably impact the forecast. As such, the forecast is not a definitive future, but a likely picture of growth given today's land use and planning assumptions. In order to use the forecast responsibly, it is recommended that users become familiar with the assumptions and methods that are presented in this document.

The 2040 Socioeconomic Forecast was built on a 2016 base year socioeconomic estimate, thereby representing 24 years of growth between the base year and the horizon year. When analyzing anticipated growth over time using the 2040 Socioeconomic Forecast it should always be in comparison to the 2016 base year. The 2040 forecast should never be compared to earlier base year estimates from previous MTPs. For example, a 2012 base year estimate was produced to support the previous socioeconomic forecast, and as such, this 2040 forecast should not be compared with the 2012 base year to analyze growth. The reason is that the 2012 estimate does not include more recent changes in policies, construction, and datasets that were included in the assumptions behind the 2040 forecast.

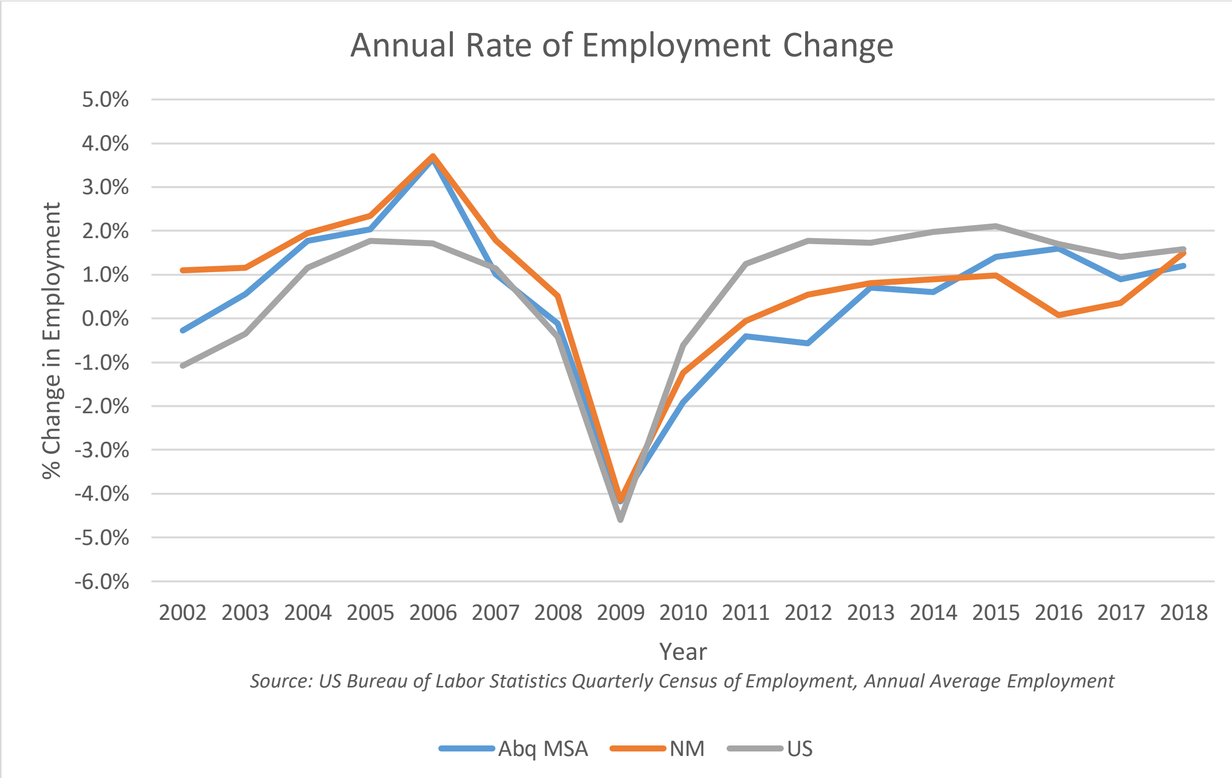
The 2040 Socioeconomic Forecast and the 2016 Socioeconomic Estimate by DASZ are available on the MRCOG website as a downloadable Excel spreadsheet and as a geographic shapefile at the following address: https://www.mrcog-nm.gov/196/DASZ-Datasets. The website holds a geographic shapefile containing the forecast data which allows information to be viewed interactively using spatial software. If users do not have access to spatial software, such as ArcGIS, the MRCOG website also has an Excel table of the forecast by DASZ which can be used in combination with pdf maps of the DASZs so the data can be located spatially using these maps.

Regional Context

The production of a regional socioeconomic forecast relies on a combination of recent and long-term trends. MRMPO integrates the most current information available in order to incorporate up-to-date social, economic, and demographic indicators at the time of its production.

The 2040 Socioeconomic Forecast was developed between 2016 and 2020 and coincided with a period of economic growth for the region.

Figure 2: Annual Rate of Employment Change, 2002 – 2018

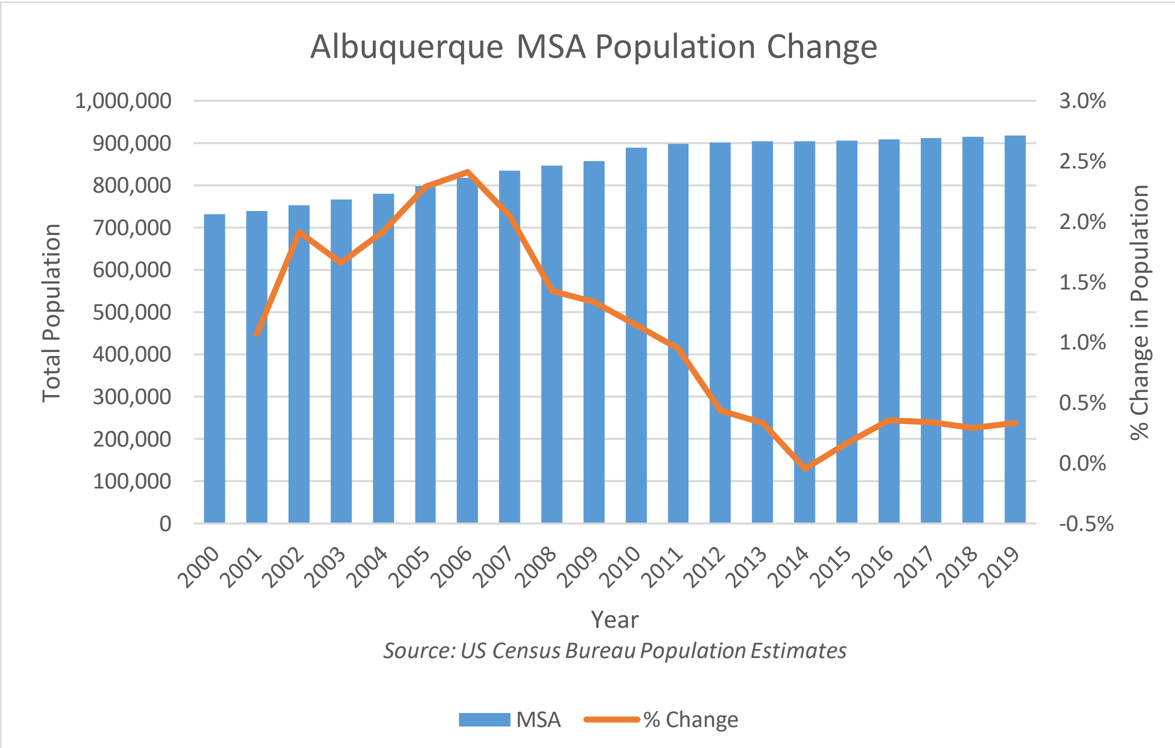


The Albuquerque Metropolitan Statistical Area (MSA) was hit particularly hard by the Great Recession.[1] Between 2007 and 2009, both the nation and the Albuquerque MSA lost approximately 4.9 and 4.6 percent of employment, respectively. However, by 2012 the nation had recovered much of that loss, while the Albuquerque MSA was still shedding jobs. Between December of 2007 (when the state officially entered the recession) and 2012 the state lost approximately 6.0 percent of all non-agricultural employment (51,500 jobs) and the MSA shed 8.0 percent (32,000 jobs). Since 2012, job growth in the MSA has moved into positive territory and has recovered to pre-recession employment levels with over 378,000 jobs.

Sustained losses in employment beginning in 2007 were accompanied by slowed population growth within the Albuquerque, MSA. Between 2000 and 2013 the MSA grew by just over 24 percent. Since the end of the recession population growth has stayed positive, but flat, near 0.3 percent. Figure 3 illustrates the overall population growth since 2000 and the percentage change from the previous year in order to demonstrate this decline.

[1] The Metropolitan Statistical Area consists of Bernalillo, Sandoval, Torrance, and Valencia Counties.

Figure 3: Population Change in Albuquerque MSA, 2000 – 2019



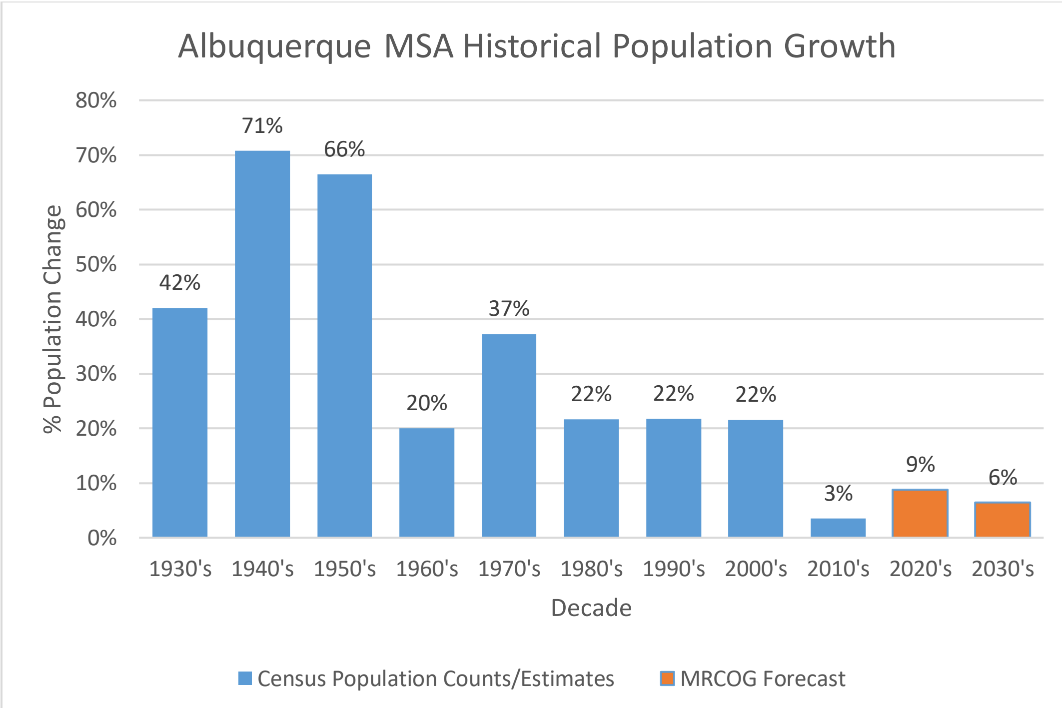
The declining growth rate is primarily due to slowed migration. For the past four decades, the region has seen positive net migration, and according to U.S. Census data, 58 percent of its growth between 2000 and 2010 was attributed to migration. Recently however, migration has slowed tremendously and actually dipped into negative territory from 2012 to 2015. Net migration from 2016 to 2019 is again positive but remained well below pre-recession levels. Lower migration in addition to declining birth rates (a local and national trend) has kept population growth much below what it was in previous decades in the Albuquerque MSA.

Long-Term Trends

For the purposes of long-term forecasting, it is important to view recent trends within the context of the long-term historical growth. The region's population is projected to grow by 20 percent by 2040, and jobs by 17 percent, which are markedly lower than the forecasts that accompanied MRMPO's previous forecast in the 2040 Futures MTP. The slow growth trends of the past decade directly contribute to the reduced growth seen in the current forecast. The Albuquerque area has fully recovered from the Great Recession but has not seen the population or job growth experienced in previous decades.

Historical trends allow us to see how past fluctuations in the pace of growth have compared to overall population growth.

Figure 4: Average Annual Growth Rate in Albuquerque MSA, 1930 – 2019



In 1930, the region had a population of just 75,000. During the 1940s and 1950s the region experienced a population boom related to an increase in federal defense spending related to World War II and the Cold War, which was accompanied by western expansion. During the 1970s, the area's economy began to diversify with the development of high-tech industries which hastened population growth. Both the fast-paced growth of the 1970s and again in the 2000s, which was marked by high migration and a housing boom, was weighted heavily in the beginning half of the decade and dropped off rapidly after the onset of the Great Recession. While the recession has unquestionably been devastating to the economy, it is clear that the story of growth in the region is one characterized by volatility and fluctuation.

Advances since the previous forecast

MRMPO has an ongoing commitment to updating its databases with the most current information available and enhancing its forecasting tools. This commitment is supported by new advances in technology, data and information. Through investigating new tools and best practices, MRMPO is able to consistently evolve and improve its forecasting methodology. The 2040 Socioeconomic Forecast incorporates new datasets, new data cleaning methods, and an updated land use model, thereby building upon an already strong foundation with the goal of making the regional forecast even more accurate.

Specifically, the 2040 Socioeconomic Forecast incorporates the following:

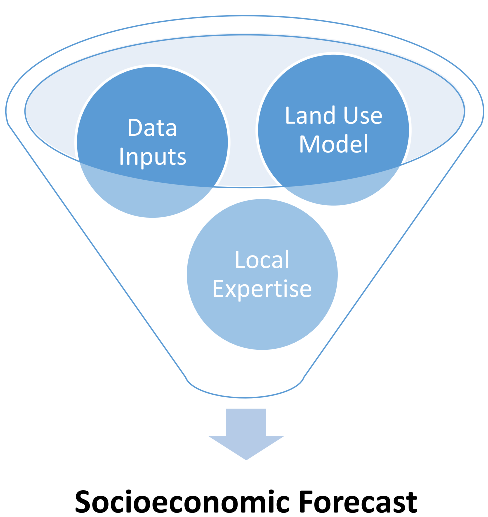
- New regional forecasts for 2040 population (released in November of 2016 by the University of New Mexico's Geospatial Population Studies Group)
- New regional forecasts for 2040 employment based on forecasts by the University of New Mexico's Bureau of Business and Economic Research and by Regional Economic Modelling Inc.
- An updated baseline of existing development and land use plans (current as of 2016)
- An update of completed, current and planned construction projects, current as of 2020.
- County assessor parcel detail including land value and year built (current as of 2016)
- Direct representation of local zoning regulation by parcel
- The implementation of a land use model update, that includes the following new features:
    - Full integration with the MRMPO travel demand model
    - A pro-forma based real estate developer model
    - An accessibility model that uses the network to calculate walking distances to jobs and amenities

Key Forecasting Components

Developing a regional forecast is a multi-year, multi-step process. The development of the 2040 Socioeconomic Forecast began in early 2016 and ended in April of 2020. The development of the 2040 forecast coincided with the development and implementation of MRCOG's land use model, which was custom built and implemented between 2016 and 2020.

There are three main components to creating a socioeconomic forecast at a small geographic scale: good data, a trusted land use model, and local expertise.

Figure 5: Three Components of a Socioeconomic Forecast



Data Inputs

The first component in creating a forecast is collecting recent, reliable, and quality data that pertains to existing land use, potential development and development constraints. Where datasets are missing or incomplete, researchers must try and fill the gaps with the best information they have at the time. Data availability and quality in the MRCOG region have improved substantially over time as technology and tools have evolved. In addition, MRCOG created a data regeneration system that checks for anomalies and omissions in public data and fills and smooths data gaps with secondary data sources and automated routines. These advances represent a giant leap for the integrity of MRCOG's forecasting processes because a forecast is only as strong as the data on which it is based.

Land Use Model

A second component in creating a forecast is the land use modeling system. Depending on the resources and staff at an MPO, this step can be as simple as an excel spreadsheet and as complicated as an integrated land use simulation and forecasting system. The benefit of using a land use model is that it introduces a high level of objectivity and rigor into the forecasting process. That is, the majority of processes are automated such that the model allows equations to drive forecasts rather than manual intervention, thereby ensuring results are based on well-documented land use theory and historical behavior rather than user bias. MRCOG employs the UrbanSim land use model.

Local Expertise

The third and perhaps most important component of developing a quality regional forecast is soliciting and integrating the input of professionals who are actively building residential and commercial developments and developing land use plans and policies. There are many points throughout the forecasting process where this occurs: during the development of the base year estimate, during the development of the "pipeline projects" input to the UrbanSim model, and following the production of draft forecasts. This feedback is gathered in a variety of ways that include holding personal interviews and distributing interactive forecast maps. Feedback was solicited from individuals involved with both the public and private sectors as well as representatives from the region's educational institutions.

Ultimately, MRCOG analysts strive to build a forecast framework that is unbiased, reliable and accurate, while maintaining a level of flexibility for incorporating local feedback.

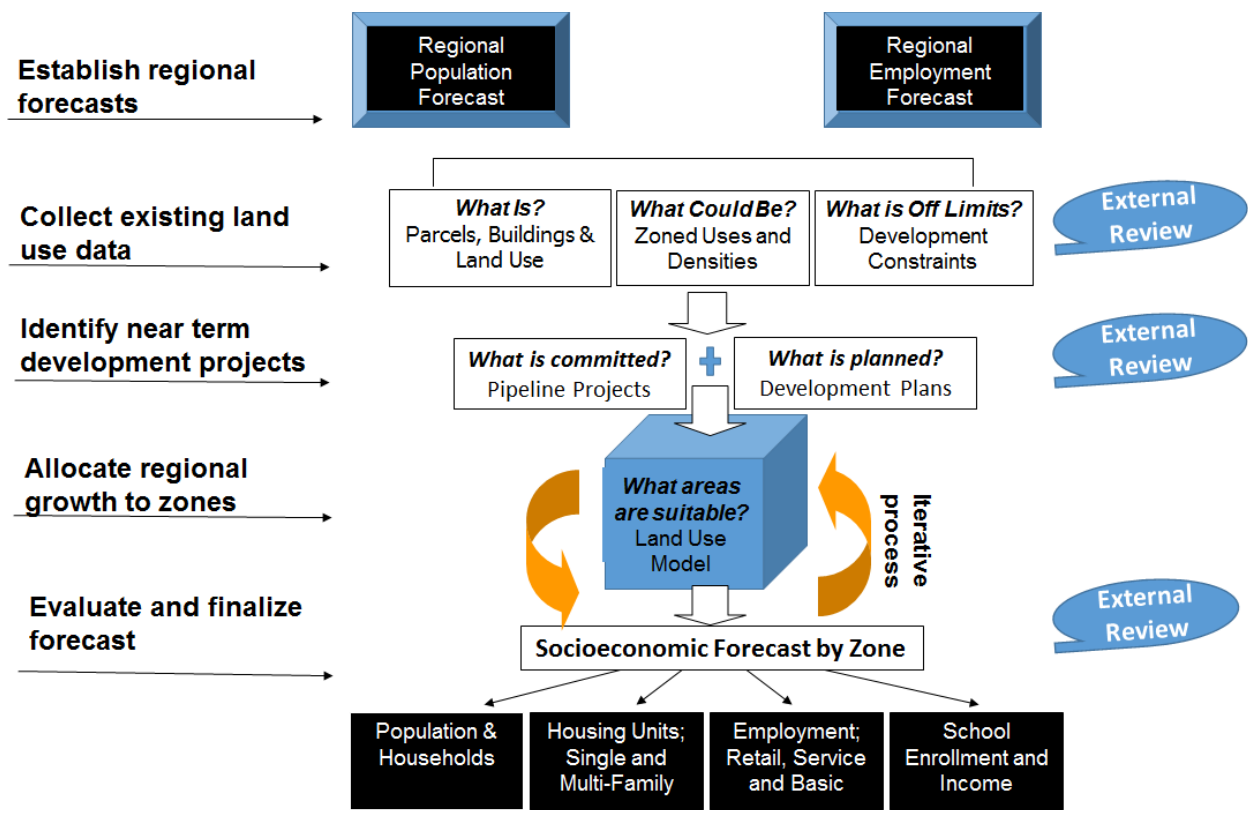
Forecast Methods

MRMPO combines the three forecasting components within a general framework that is followed in order to generate a regional socioeconomic forecast. The framework consists of five basic steps:

1) Establish regional forecasts
2) Collect existing land use data
3) Identify near term development projects
4) Allocate regional growth to zones
5) Evaluate and finalize forecast

The figure below illustrates the socioeconomic forecasting process.

Figure 6: Socioeconomic Forecasting Process



This document describes this general socioeconomic forecasting process including the key datasets and steps. It includes high level information about the UrbanSim land use model development as it supports the understanding of the forecasting process. A methodology document that contains greater detail regarding the UrbanSim model will be produced separately.

Establish Regional Forecasts

Figure 7 illustrates the sources used for establishing regional forecasts that constitute the "ceiling" or control total on growth that is available for allocation by the UrbanSim land use model.

Figure 7: UrbanSim Regional Forecast Sources

UrbanSim Regional Forecast Sources		
Population	Households	Employment
UNM-GPS 2040 Population Projections, MRCOG	Woods & Poole Household Size Forecast, MRCOG	UNM-BBER 2023 Forecast, Regional Economic Models Inc. 2040 Forecast, MRCOG

Population

A regional 2040 population forecast was produced as an input to UrbanSim. The population forecast is based on the 2040 population projection by the University of New Mexico's Geospatial Population Studies (GPS), which was released in November 2016. GPS projections are based on a demographic forecasting technique called the cohort-component method. This method incorporates historical birth, death and migration rates and applies them to age cohorts that are moved forward in time. Since the 2040 projection series was released at the end of 2016, it had the benefit of building in much of the Great Recession into its baseline assumptions.

MRCOG performed several modifications to this dataset in order to prepare it for the 2040 MTP. The GPS projection was aggregated to the four-county area and this regional sum was used as the population control total for the region. This regional control total, and not the county level projections, was used as the control total, or "ceiling," on regional growth. This allowed county and sub-county growth to be rooted in market influences, land availability and policy. Additionally, MRCOG developed a custom forecast for the southern Santa Fe portion by applying GPS growth rates from Santa Fe County to the current southern Santa Fe estimate.

Households

Population was translated into household population and ultimately, households, for compatibility with the land use model. This was achieved first by forecasting group quarters population and subtracting that from total population to derive household population. The group quarter's population was forecast by group quarter's segments including: nursing home population, corrections population, dormitory population (military and college), and other. Nursing home, corrections, and dormitory populations were forecasted using historical age-based ratios which were applied to the GPS projection. The remainder of the group quarters population (other, institutionalized and non-institutionalized) was forecast based on historical trends. Lastly, an average household size forecast by county available by Woods and Poole Economics was applied to the derived household population in order to generate a forecast for households. Figure 8 illustrates this process.

Figure 8: Key Population Equations

Group Quarters Population = Nursing Home + Corrections + Dormitory + Other

Household Population = Total Population - Group Quarters Population

Households = Household population / Average Household Size

Employment

A regional 2040 employment forecast by 2-digit sector as defined by the North America Industrial Classification System (NAICS) was produced as an input to UrbanSim. To the extent possible, MRCOG based this forecast on the 2017-2023 employment forecast produced by the University of New Mexico's Bureau of Business and Economic Research (BBER). BBER regularly produces short term, six year employment forecasts by industry sectors for the Albuquerque MSA. Other data sources include: 1) 2016 Quarterly Census of Employment and Wages (QCEW) employment data by sector data from the New Mexico Department of Workforce Solutions; 2) 2016 Employment by sector and location from InfoGroup, a third party vendor of site-based employer information that is checked and verified by MRCOG; and 3) forecasts of employment by sector from the REMI TranSight model. The following steps describe the procedure used to create the 2017-2040 employment forecast.

The first step in the forecasting process is to reconcile differences between BBER's employment and MRCOG's travel model requirements. MRCOG's employment definition includes *all* jobs including self-employment and agricultural jobs, therefore the BBER forecast was augmented with self-employment data from the ACS 'class-of-worker' data and agricultural employment from the Bureau of Economic Analysis (BEA). BBER sectors, which are a combination of NAICS classifications and the older Standard Industrial Classification (SIC) classifications, were adjusted to the 2-digit NAICS categories using simple linear regressions of QCEW data. In addition, MRCOG supplemented the BBER forecast, which is available for the Albuquerque MSA, with employment for Southern Santa Fe County using 2016 employment data from InfoGroup and forecasted it using a weighted average to the rest of the region. Next, the forecast was extended from 2023 to 2040 using the 2 digit NAICS Employment forecast from REMI.

At the time of the forecast, there were no known plans to expand or reduce activity at the Kirtland Airforce Base and as such, BBER's 2023 forecast of military employment was assumed to remain constant between 2023 and 2040. However, two large employers, Sandia Labs and Intel announced plans to add 1200 and 300 employees respectively. These additions were asserted into the regional forecast as well as the small area forecasts.

Collect Existing Land Use Data

The production of a small area socioeconomic forecast is also a land use forecast. That is, one must first determine that an area can accommodate the future population and employment. A clear picture of existing land use, available land, allowable uses and densities, and development constraints is important to produce a forecast that is rooted in reality. In fact, it is this information that allows MPOs to adhere to the federal requirement that the socioeconomic forecast conforms to local land use policies.

The following table outlines the key tables, attributes and sources for incorporating existing land use data into the UrbanSim land use model.

Figure 9: Existing Land Use: Tables, Sources, and Attributes

Existing Land Use: Tables, Sources and Attributes				
Required Tables	**Parcels**	**Buildings**	**Zoning**	**Development Constraints**
	Land use type	Building type	Allowable uses	Undevelopable area
	Land value	Improvement value	Maximum units (residentials)	Water and sewer infrastructure
	Acres	Square footage	Maximum floor to area ratio (commercial)	Paved roads
		Number of units		
		Stories		
		Year built		
		Market value		
Sources				
	Assessor Data	Assessor Data	Local Zoning Code	Drainage
	Land Use Files	Land Use Files	Master Plans	Parks and Open Space
	Master Plans	CoStar	Sector Plans	Forest Land
		MetroStudy	Planner Interviews	Conservation Land
		Building Permits		Tribal Land
				Kirtland Air Force Base
				NMDOT paved roads file
				Water Authority

Several key data tables are instrumental to achieving a reliable land use forecast:

Parcels

Because UrbanSim is a highly disaggregated model, it requires detail down to the parcel level. All parcel boundary files are collected and compiled from the individual county assessor offices in the region. The parcel file contains data related to size of parcel, land use, and value.

Buildings

UrbanSim requires a representation of specific building types that exist on each parcel. This data also begins with county assessor records, and this is provided to MRCOG whenever possible. MRCOG requests detail related to number of units, square footage, year built, stories, and improvement value. While detailed building type (beyond residential, commercial and vacant) is not explicitly available publicly from any data source, most local jurisdictions do maintain a land use file that assigns a detailed land use type to each parcel or group of parcels. As such, these detailed land use types are used as a proxy for building type. In general, parcels that are categorized as vacant, open space, transportation, agricultural, rangeland, drainage, and utilities are not assumed to have buildings assigned to them unless confirmed by a primary or secondary data source.

The region's larger jurisdictions such as City of Albuquerque and City of Rio Rancho maintain a land use inventory, which are kept up-to-date as changes occur. Most of the rural jurisdictions make updates only when undergoing updates to their comprehensive plans. MRCOG often provides technical assistance with land use inventory development to most of its rural jurisdictions and as such the data exists in-house already.

Zoning

All regulatory documents including plans and zoning codes are collected from local jurisdictions. These codes are translated into a spatial representation of the allowable uses and densities on every parcel. Some plans include specific information related to exact uses, number of dwelling units, and commercial floor-to-area ratios. In others, the code is more open to variability (e.g., special use zones and overlay districts). In such instances, local planner guidance in determining most likely approximations was critical.

Development Constraints

There are many parts of the region that are not available for future development. Barriers to future development may be based on existing topographical constraints and land ownership. Spatial layers used to develop this file include natural drainage, transportation and utility infrastructure, national and state parks, US Forest Service, public open space, and Tribal lands. These files were merged to create a single layer referred to as the "undevelopable layer." The undevelopable layer was overlaid on top of a regional parcel file and where there was overlap, the percentage of each parcel covered by the undevelopable layer was calculated and prohibited from receiving allocated growth.

The development constraints ensure that the forecast is rooted in reality. For example, it will prohibit houses being built in the Rio Grande or an office park developed on Petroglyph National Monument in the model's allocation of population, housing and employment. There are some instances were agricultural land has been converted to another use, such as farmland being redeveloped into residences or higher intensity manufacturing uses, and the model accommodates this. Conversely, developable land is occasionally purchased and set aside by jurisdictions for open space, and when this occurs that land is added to the undevelopable layer.

Parcels, buildings, zoning, and development constraints are combined to define the characteristics of each parcel in the region including existing use, intensity of use, and the remaining capacity for future use.

Remaining Capacity = Zoned capacity – (existing development + undevelopable land)

This data informs the land use model about what is on the ground today and how much more development an area may reasonably consume, thereby ensuring that the zone-level forecast does not exceed allowable future growth potential.

Identify Near Term Developments

Pipeline Projects

In order to ground the forecast in the existing local real estate market, the land use model is programmed to integrate current and near-term projects that are expected to be constructed, oftentimes referred to as "pipeline projects." This information is gathered through local jurisdictions' development review processes, developer and planner interviews, and local news and media. Projects are inserted into the forecasting process through a table of *scheduled development events*. This table includes project-level detail that describes expected start dates, end dates, number of units, and the anticipated square footage of the building or collection of buildings. Pipeline projects have a fairly high level of certainty as they are either currently being built, have attained building permits, or have a formally approved site development plan. These include active phases of major subdivisions. These projects are tagged as "committed," which instructs the model to build them as specified by the plans.

Development Plans

The land use model also incorporates consideration of master plans that have been approved by local jurisdictions and some conceptual plans that have been established as likely future development via interviews with the planning and development communities. If an approved plan involves a zone change, those changes are reflected in the underlying zoning definitions. While these development plans and projects have been determined to be reasonably likely by local experts, there is an acknowledgement that they are still subject to market changes and pressures which could affect the feasibility and/or timing of the project.

Allocate Regional Growth to Zones

Following the development of forecast control totals and data collection and preparation, regional growth is distributed to individual parcels and then aggregated by data analysis subzone (DASZ). MRMPO strives to ensure that this process is as informed and objective as possible. The informed piece comes in the form of good data and local expertise. The objective piece is achieved through the development of a land use model that is created for the purpose of allocating regional growth to zones, rather than a manually developed forecast based on stakeholder judgement and desires.

MRMPO operates a customized, state-of-the-art land use model called UrbanSim. UrbanSim model is essentially the engine of the forecasting process; it is responsible for allocating future households and jobs to parcels based on a set of locally defined parameters and constraints. UrbanSim is a predictive model, which means that it allows the user to simulate real world household and business decisions based on a variety of factors that have proven to be significant in influencing historical development patterns. The forecast is rooted in existing plans and policies, past trends, and market behavior. This is in contrast to sketch forecasting tools, which usually simulate a regional vision rather than a prediction. The idea behind developing a predictive forecast is to illustrate a likely future given current conditions so that communities can both plan for the future and make changes in order to mitigate undesirable outcomes.

UrbanSim Overview

UrbanSim is a microsimulation land use model designed for analyzing the potential effects of land use policies and infrastructure investments on the development and character of the region. The modeling system relies upon a data-driven, transparent, and behaviorally-focused methodology that is designed to attempt to reflect the interdependencies in dynamic urban systems, focusing on the real estate market and the transportation system, and on the effects of individual and combinations of interventions on patterns of development, travel demand, and household and job location. UrbanSim has become the operational modeling approach for a variety of metropolitan areas in the United States and abroad, and is actively used by planning organizations in Austin, Chicago, Denver, Detroit, Honolulu, Phoenix, Minneapolis, Salt Lake City, San Diego, San Francisco, Eugene-Springfield, Seattle, and Paris among others.

UrbanSim works by simulating the interactions among households, businesses, and developers within real estate markets. By modeling the real-world trade-offs between housing costs, accessibility, and various other amenities, UrbanSim predicts households' location choices. UrbanSim also replicates local employment dynamics, including a firms' location choices. Furthermore, the model simulates developers' choices of what kind of buildings to build, where, and when, and whether to redevelop existing properties. Land use policies constrain what developers can build, and transportation plans modify accessibility patterns, which influence the attractiveness of different locations for households and firms. These dynamics influence prices and rents and the market conditions for new development or redevelopment.

UrbanSim simulates changes by single year increments, and the results of one year provide the starting point for the next simulation year. This method closely replicates the way that urban areas evolve, year over year, with mismatches between the supply and demand of housing and jobs. Typically, metropolitan areas see only a small fraction of the housing stock added in a given year. Development of real estate proceeds slowly in response to rapid changes in demand, leading to swings in vacancy rates and prices, and to the commonly observed booms and busts in real estate cycles.

Key conceptual underpinnings of UrbanSim include:

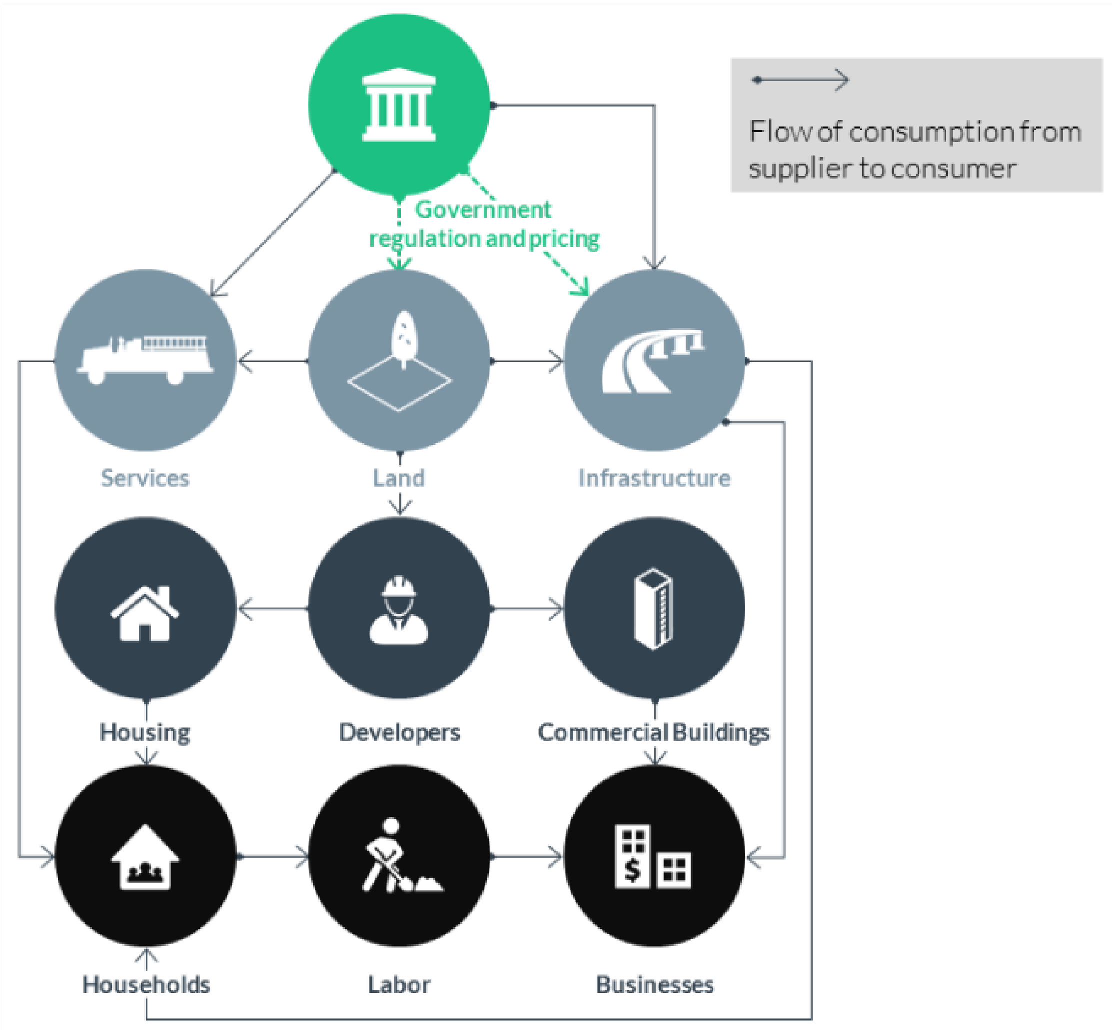
- Representation of individual decisions made by households, employers, people and jobs.
- Representation of the supply and characteristics of land and of real estate development.
- A dynamic perspective of time, with the simulation reacting to changing conditions year to year.
- The use of real estate markets as a central organizing focus, with consumer choices and supplier choices explicitly represented, as well as the resulting effects on real estate prices. The relationship of households or employers to real estate tied to specific locations provides a simple accounting of space and it's use.

- The use of Multinomial Logit Models to represent the choices made by households, employers and developers (principally location choices).
- Integration of the urban simulation system with existing transportation model systems, to obtain information used to compute accessibilities and their influence on location choices, and to provide the inputs to the travel models.

Model System Design

In the UrbanSim model, buildings are located on parcels that have particular characteristics such as value, land use, and developable area. Local municipalities set policies that regulate the use of land, through the imposition of zoning or through pricing policies such as development impact fees. Municipalities also build infrastructure, including transportation infrastructure, which interacts with the distribution of activities to generate patterns of accessibility at different locations that in turn influence the attractiveness of these sites for different consumers. Households have particular characteristics that may influence their preferences and demands for housing of different types at different locations. Businesses also have preferences that vary by industry and size of business (number of employees) for alternative building types and locations.

Figure 10: Households and Employer Interactions within Real Estate Markets



UrbanSim predicts the evolution of households, employers and their characteristics over time, using annual steps to predict the movement and location choices, the development activities of developers, and the impacts of governmental policies and infrastructure choices. The land use model is interfaced with MRMPO's travel model system to deal with the interactions of land use and transportation. Access to opportunities, such as employment or shopping, are measured by the travel time or cost of accessing these opportunities via all available modes of travel. See the travel model integration section for details.

MRMPO uses exogenous regional employment and population forecasts as control totals, meaning that these are inputs that are not predicted directly by UrbanSim or MRMPO. The University of New Mexico Bureau of Business and Economic Research (UNM-BBER) uses a macroeconomic model to predict short term future employment by sector which is supplemented by MRMPO using a long-term employment forecast from Regional Economics Modelling Inc. (REMI) to create a regional employment control total. The University of New Mexico Geospatial Population Studies (UNM GPS) develops county level population projections using the cohort component method which relies on predicting births, deaths and migration that is used as a population control total.

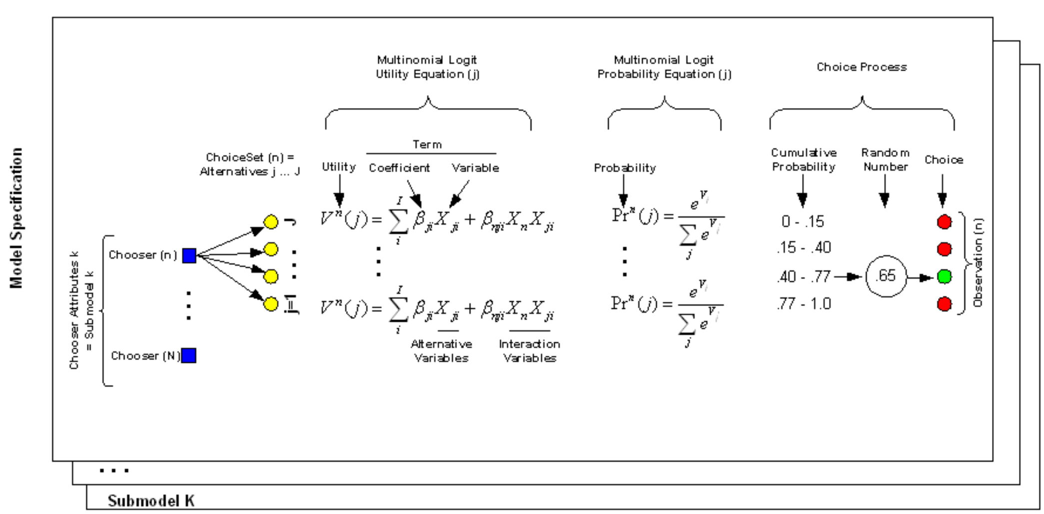
UrbanSim Inputs

- Employment data from New Mexico Department of Workforce Solutions and InfoGroup
- Household data merged from multiple U.S. Census sources and ESRI Business Analyst Online
- Municipal, County, Tribal and State land use plans and regulations such as zoning
- Undevelopable land, Federal land, Tribal land, and State land boundaries
- Congested travel times from the Cube travel demand model
- Parcel database supplemented with local data pertaining to land use, housing units, nonresidential square footage, year built, land value, and improvement value. Sources include County Assessors, local planning Geographic Information Systems (GIS) databases, CoStar, Metrostudy, and building permits issued for new construction (See Figure 9 above).
- Average construction costs from RSMeans

Discrete Choice Models

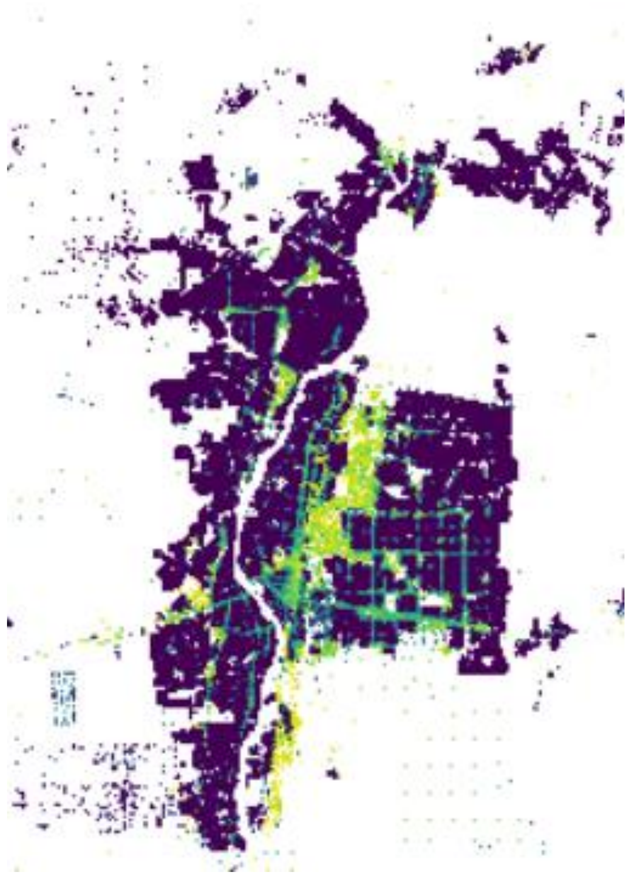
UrbanSim makes extensive use of discrete choice models where individual households and employers choose buildings. First, multinomial logit models are estimated based on the variables that have proven to be statistically significant in explaining past behavior. For example, households that moved to the region in the last 5 years are evaluated based on the census tracts that they chose to move to. The estimated model then generates a probability that a particular household (based on income and other characteristics) will pick a particular housing unit (of different sizes, prices and other characteristics). In order to predict choices given the predicted probabilities, the choice algorithm uses a sampling approach. As illustrated in the figure below, a choice outcome can be selected by sampling a random number from the uniform distribution in the range 0 to 1, and comparing this random draw to the cumulative probabilities of the alternative housing units. Whichever alternative the sampled random number falls within is the alternative that is selected as the 'chosen' one. This algorithm has the property that it preserves in the distribution of choice outcomes a close approximation of the original probability distribution, especially as the sample size of choosers becomes larger.

Figure 11: UrbanSim Choice Models



The figure below shows an example of the probability of an employer selecting a particular parcel in the Albuquerque Metropolitan area, yellow indicates areas that are more attractive for employers.

Figure 12: Sample probability of a manufacturing firm locating on a particular parcel

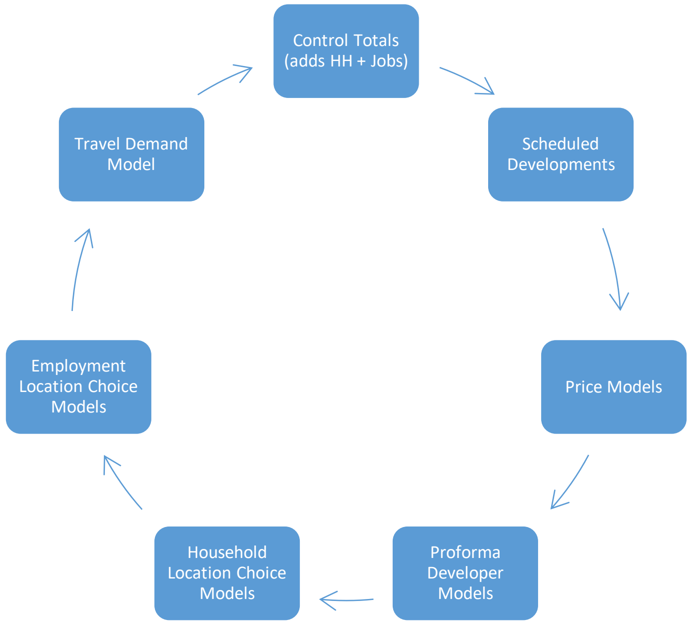


Note: Purple is low probability and yellow is high probability

Model Steps

Each simulation year follows the steps seen in Figure x. First, the control totals developed externally by UNM and REMI determine how many new households and jobs are introduced to the region. Next, the known scheduled developments are built. Next, the Price Models update real estate prices followed by the proforma and developer steps calculating costs of potential sites and then building new buildings that are profitable. Next, the Household and Employment Location Models place households and jobs into empty buildings based on the predicted attractiveness of each site. Finally, because the spatial allocation of people and jobs has been altered, the Travel Model is updated and calculates new congested travel times. The updated travel times will affect the next year's prices and location choices.

Figure 13: Model steps in each simulation year



Developer Models

- **Scheduled Developments:** Known development projects that are either currently under construction or set to begin building in the near term are added to the simulation in the appropriate year. This allows areas of current growth to be seeded with real projects and updates the base year data from 2016 to current conditions.
- **Proforma:** Computes the costs and revenues of feasible development projects allowed by zoning and creates new buildings. Costs include: construction costs, demolition costs (if parcel is not vacant), financing costs, and parking construction costs. Using the modelled prices from the Price Models to estimate potential revenue of different developments, the most profitable development projects are built in each simulation year.

Price Models (Ordinary Least Squares Regression)

- **Commercial Price Models**: These models are segmented by office, retail, and industrial. Important estimation variables include: accessibility to workers (based on travel model outputs), year built, proximity to freeway exits, size of parcel or building, within ‘key center’, accessibility to other employers (clustering effect).
- **Residential Price Model**: Important estimation variables include: accessibility to jobs (based on travel model outputs), proximity to industrial sites (negative coefficient), income level of neighborhood, access to transit, year built, and access to retail or food services.

Location Choice Models (Multinomial Logit)

- **Employment Location Choice Models**: These models are segmented by employment sector. Important estimation variables include: commercial rent/price per square foot, size of parcel or building, type of commercial building, year built, accessibility to other employers (clustering effect) and accessibility to workers.
- **Household Location Choice Models**: These models are segmented by income. Important estimation variables include: rent or price per residential unit, unit square feet, year built, accessibility to jobs (based on travel model outputs), access to transit, access to retail or food services, average household size of neighborhood, and income level of neighborhood.

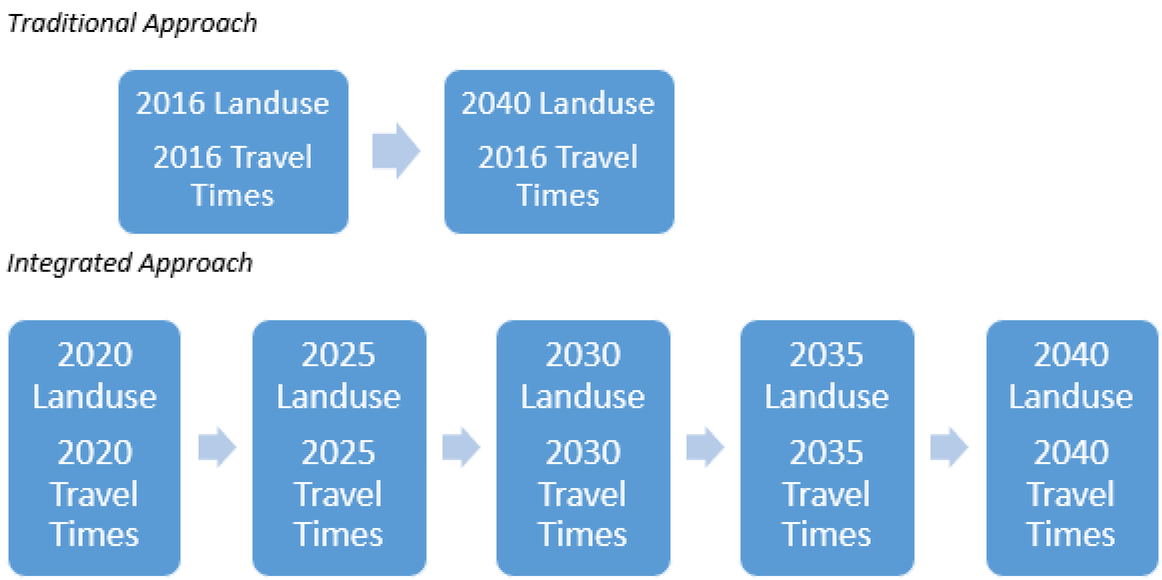
Integrated Modelling Approach

An integrated modelling approach that combines land use and travel demand is improves the ability to reflect future conditions that are representative of the dependencies between housing and employment choices and congestion.

Without the travel demand model, the land use model uses only one set of travel times throughout the whole simulation, meaning that regional growth does not affect travel times and congestion does not affect future growth. In contrast, when the land use model runs interactively with the travel demand model, the travel times get updated every time the travel demand model runs. The interaction between the two models occurs every 5 years starting in the simulation year 2020 and concluding in 2040. With each iteration of the travel demand model, land use development patterns are modified because travel time is a factor when deciding where to build future development.

The following picture illustrates the differences between a traditional and an integrated model approach to predicting future land use.

Figure 14: Travel Model Integration



The table below shows the differences in expected growth between the traditional modeling approach and the integrated approach. The travel demand model results are based on a "no build scenario", in which the base 2016 roadway network remains static in order to create a true comparison between the two runs.

Figure 15: Forecast Differences by County when Applying an Integrated Model Approach

County	Jobs	Households
Bernalillo	0.13%	1.45%
Sandoval	-1.25%	-3.60%
Valencia	-2.99%	-4.97%
Torrance	-4.74%	-7.35%

All counties except Bernalillo County show a declining share of growth within an integrated modeling framework. This reflects the decreased access to key destinations from surrounding counties when future congested travel times are introduced. As congestion levels rise, Valencia, Sandoval and Torrance become less attractive for future development given that many trip purposes and in particular work commutes are destined for Bernalillo County.

Integration between the land use and travel demand models is a more realistic approach to forecasting. By allowing the models to interact we are able to better simulate real world decision-making as we know that issues of congestion and travel times to common destinations often play a role in where households and employers chose to locate.

Assumptions and Limitations of UrbanSim

UrbanSim is a model system, and models are abstractions, or simplifications, of reality. Only a small subset of the real world is reflected in the model system, as needed to address the kinds of uses outlined above. Like any model, or analytical method, that attempts to examine the potential effects of an action on one or more outcomes, there are limitations to be aware of.

- *Boundary effects are ignored.* Interactions with adjacent metropolitan areas pose modeling difficulties due to boundary effects. For example, MRMPO does not model interactions with Santa Fe even though residents of the Mid-Region work in Santa Fe or vice-versa.

- *Zoning regulations are assumed to be binding constraints on the actions of developers.* Parcels are constrained by their zoned densities with the exception of the known scheduled developments which are always built, and approved master planned areas which are updated to reflect the intended uses and densities shown in the plans.

- *UrbanSim is a regional land use model and results should not be used at a parcel level.* While UrbanSim is a microsimulation model, results are intended to be aggregated to larger geographies such as DASZs in order to avoid the inaccuracy inherent at the parcel level.

- *Behavioral patterns are assumed to be relatively stable over time.* The UrbanSim model assumes that behavioral patterns will not change dramatically over time. Models are estimated using observed data, and the parameters reflect a certain range of conditions observed in the data. If conditions were to change dramatically, such as fuel prices tripling and continuing to increase, it is probably the case that fundamental changes in consumption behavior, such as vehicle ownership and use, would result.

Evaluate and Finalize Forecast

With more than 600,000 parcels and 300,000 buildings spread across 926 zones and 9,600 square miles, it can be a daunting task to evaluate a socioeconomic forecast. In order to distill this process into a manageable form, MRMPO developed several automated indicators that are essentially a series of summary tables that allow reviewers to interrogate and evaluate each simulation from a variety of angles. These summaries are as follows:

Regional Summary: Key variables including new households and employment by sector were compared against 2040 control totals for accuracy.

County Summary: Key variables including new households and new jobs were compared to previous forecasts, baseyear distributions and recent growth trends.

REMI Area Summary: Key variables including new households and new jobs were compared to previous forecast, baseyear distributions and recent growth trends.

Subarea Summary: Key variables including new households and new jobs were compared to Master plans and recent growth trends.

DASZ Summary: Key variables such as new households and new jobs were visualized by zone in ArcGIS and evaluated based on known growth expectations as gathered through the development review process and interviews.

These summary tables combine with professional judgement and user feedback to constitute an interactive process to evaluate the success of a simulation in creating a reasonable and accurate forecast that is rooted in both local expertise and technical rigor.

There were three key points where MRMPO sought broad feedback from the planning and development communities. First, outreach and interviews were performed to develop the inputs regarding pipeline projects and known developments. Second, MRMPO developed a series of initial draft forecast maps that were reviewed by many of the same people who were interviewed during the first round of outreach. These were personal meetings and interviews which led to a second round of simulation enhancements. After the second draft was developed, MRMPO created an interactive online map that showed new households and employment by zone. The link to this map was provided to the forecast reviewers from the first two meetings for yet a third round of feedback from local development experts. In addition, MRMPO staff continued to review the forecast internally and incorporate refinements as necessary. Following these efforts, the forecast was ready to be finalized.

The finalization phase is the very last step of producing a forecast, and it includes a variety of technical quality checks and cleaning that relate to the land use model output in order to develop a socioeconomic dataset that is ready to be integrated into the travel demand model and distributed to member governments for their use.

The primary emphasis of the forecast finalization step includes:

- Small rounding adjustments to population to match regional forecast
- Review vacancy rates and perform minor adjustments where necessary
- Review household sizes and perform minor adjustments as necessary
- Apply final refinements that were not captured by the simulation

Off-Model Forecasts

There are some specific areas and variables that do not lend themselves to forecasting using a land use model. Kirtland Air Force Base and Tribal lands are unique in that they do not abide by the general market-based theory implemented in UrbanSim. For example, Air Force Base jobs are determined primarily by federal government contracts and programs and are not suitable for a site selection analysis in that there is only one area to locate such jobs—on the base. Tribal governments often have requirements about who can own a home and operate a business on tribal lands and therefore it is not reasonable to subject these lands to normal market forces that drive growth. In both of these cases, forecasts are developed independent of the land use model and are attached to the socioeconomic dataset in a post-processing step.

Kirtland Air Force Base

Planners from Kirtland Air Force Base were interviewed and provided input regarding the forecast assumptions related to future housing, group quarters, and jobs on the base. Housing on the base is privatized and operated by Kirtland Family Housing LLC. At the time of the forecast production there were no plans to build new housing or demolish existing housing on the base. As such, housing was projected to remain fairly constant between 2016 through 2040. In addition, there are no explicit plans to expand group quarters facilities on the base, and as such the dormitory population is projected to see just a slight increase as existing beds are filled. Finally, at the time of the forecast there were no known plans to expand or reduce operations at the base by the federal government. Without existing data to inform an employment forecast on the base, it was determined that the appropriate course of action would be to be hold employment constant throughout the forecast period. If there is new information available at a later date it can be incorporated into future forecast updates.

Tribal Land

Tribal Governors' Offices within the region were sent formal letters inviting their participation in the forecasting process which were followed by an in-person all day even to get Tribal input on the forecast as well as the MTP as a whole. Several planners for different tribes participated in this process by providing input through interviews at the in-person event. The tribes that did not participate were forecast forward using a simple linear trend method which took into account the historical pace of growth. The growth forecast on tribal land is considered to fall within the regional control totals and therefore this off-model forecast was subtracted from the overall regional control totals available for allocation by the UrbanSim land use model to the remaining DASZs in the region.

Estimate and Forecast Summary

Total Population

By 2040 it is projected that the region will have a population of 1,121,020. The region is projected to grow by 194,000 people, which amounts to an overall 24-year growth of 21 percent or an average annual growth rate of 1 percent. By comparison, the region grew by 82 percent in the thirty years between 1980 and 2010. The growth will be shared among all counties, with Bernalillo County capturing the largest numeric growth and its surrounding counties experiencing faster growth.

Figure 16: Population by County, 2016 and 2040

County	2016 Population	2040 Population	Numeric Growth	Percentage Growth
Bernalillo	681,854	832,206	150,352	22%
S. Santa Fe	10,397	11,564	1,167	11%
Sandoval	142,066	177,390	35,324	25%
Torrance	15,584	18,319	2,735	18%
Valencia	76,484	81,541	5,057	7%
MRCOG Total	**926,385**	**1,121,020**	**194,635**	**21%**

Household Population

Household population differs from total population in that it excludes all people living in group quarters living arrangements such as prisons, dormitories, and long-term care facilities. In 2016, there were about 15,000 residents of group quarters, and this is expected to rise to approximately 21,000 in 2040. Four of every five persons residing in group quarters live in Bernalillo County. Senior living and retirement communities that do not provide live-in care are not considered group quarters, and are counted the same as any other multifamily building.

Figure 17: Household Population by County, 2016 and 2040

County	2016 Household Population	2040 Household Population	Numeric Growth	Percentage Growth
Bernalillo	670,064	815,591	145,527	22%
S. Santa Fe	10,397	11,564	1,167	11%
Sandoval	141,074	176,000	34,926	25%
Torrance	15,078	17,611	2,533	17%
Valencia	74,896	79,317	4,421	6%
MRCOG Total	**911,509**	**1,100,083**	**188,574**	**21%**

Households

Households are the equivalent of all occupied housing units. A household can be comprised of one or more persons who may or may not be related by blood or marriage. In 2016 there were 360,969 households in the region, and 911,509 persons living in households. Therefore, the average household size was 2.53 persons per household. By 2040 this will increase slightly to 2.57 persons per household as the region adds another 66,000 households and the large millennial cohort reaches child rearing age.

Figure 18: Households by County, 2016 and 2040

County	2016 Households	2040 Households	Numeric Growth	Percentage Growth
Bernalillo	272,867	320,936	48,069	18%
S. Santa Fe	3,986	4,315	329	8%
Sandoval	50,569	64,005	13,436	27%
Torrance	6,086	7,157	1,071	18%
Valencia	27,461	30,944	3,483	13%
MRCOG Total	**360,969**	**427,357**	**66,388**	**18%**

Housing Units

Housing units are the sum of all occupied and vacant housing units. The forecast includes an additional 72,000 housing units, which is an 18 percent increase over today.

Figure 19: Housing Units by County, 2016 and 2040

County	2016 Housing Units	2040 Housing Units	Numeric Growth	Percentage Growth
Bernalillo	295,704	348,729	53,025	18%
S. Santa Fe	4,426	4,733	307	7%
Sandoval	55,738	70,000	14,262	26%
Torrance	7,810	8,305	495	6%
Valencia	30,745	34,476	3,731	12%
MRCOG Total	**394,423**	**466,243**	**71,820**	**18%**

Housing units are projected to grow at the same rate as households, holding the vacancy rate at 8 percent.

Housing Type

MRCOG forecasts housing units by type, distinguishing between single family and multi-family units. Manufactured housing and unattached housing fall within the single family category, and all attached housing structures with two units or more are considered multi-family.

Currently, single family units represent 80 percent of the region's housing stock. This is expected to decline slightly to 77 percent by 2040. Approximately 28,000 new multi-family units are expected to be built over the forecast period, increasing the current multi-family stock by 35 percent. Single family units will still represent the majority of new homes; with 44,000 new single family homes they will represent two of every three new units built.

Figure 20: Single Family Housing Units by County, 2016 and 2040

County	2016 Single Family Units	2040 Single Family Units	Numeric Growth	Percentage Growth
Bernalillo	220,599	248,120	27,521	12%
S. Santa Fe	4,405	4,729	324	7%
Sandoval	52,620	64,706	12,086	23%
Torrance	7,610	8,029	419	6%
Valencia	29,360	32,916	3,556	12%
MRCOG Total	**314,594**	**358,500**	**43,906**	**14%**

Figure 21: Multi-Family Housing Units by County, 2016 and 2040

County	2016 Multifamily Units	2040 Multifamily Units	Numeric Growth	Percentage Growth
Bernalillo	75,105	100,609	25,504	34%
S. Santa Fe	21	4	(17)	-81%
Sandoval	3,118	5,294	2,176	70%
Torrance	200	276	76	38%
Valencia	1,385	1,560	175	13%
MRCOG Total	**79,829**	**107,743**	**27,914**	**35%**

Total Employment

Overall, the region is projected to gain 73,000 new jobs between 2016 and 2040 to reach a total employment forecast of 485,000. Bernalillo County, which includes the City of Albuquerque, will continue to be the economic engine for both the state and the region. With over 413,000 jobs in 2040, it will contain four out of every five jobs in the region. However, it is notable that surrounding counties are expected to see much faster job growth. Sandoval County will see more substantial employment growth than it has seen in the past, as it is forecast to grow by 20 percent. This growth is driven by the City of Rio Rancho, which is expected to attract new jobs in order to meet the demands of a growing population. There is evidence of this potential by its rapidly expanding health services sector. Valencia

County is also expected to see a 19 percent employment expansion that will help to provide more convenient options for the existing workforce and grow local economies.

Figure 22: Employment by County, 2016 and 2040

County	2016 Jobs	2040 Jobs	Numeric Growth	Percentage Growth
Bernalillo	352,002	413,338	61,336	17%
S. Santa Fe	1,784	2,111	327	18%
Sandoval	35,852	42,991	7,139	20%
Torrance	4,322	5,118	796	18%
Valencia	18,123	21,606	3,483	19%
MRCOG Total	**412,083**	**485,164**	**73,081**	**18%**

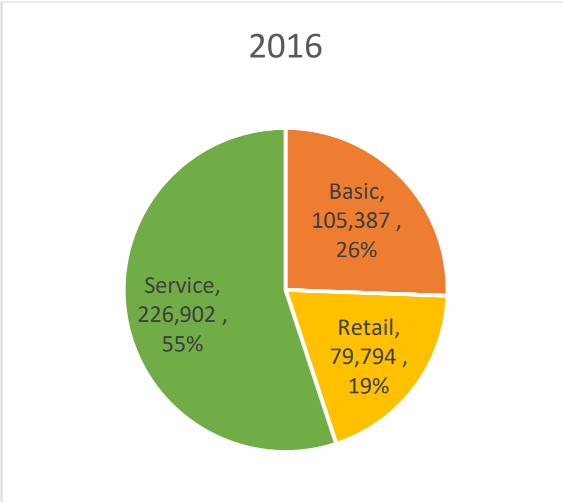
Basic, Service and Retail Employment

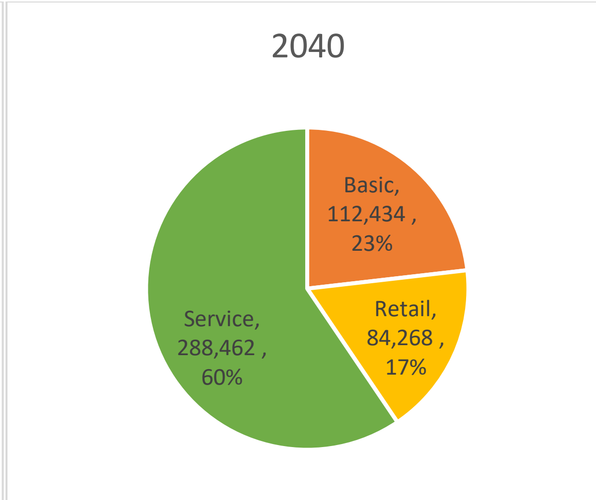
MRCOG identifies three broad employment groups for travel demand modeling purposes: basic, retail, and services. They include the sectors listed below, which are based on the two-digit North American Industrial Classification System (NAICS):

> Basic - agriculture, mining, construction, manufacturing, transportation, communications, utilities, wholesale, military
>
> Retail - retail trade, eating and drinking establishments
>
> Services - finance, real estate, professional and technical jobs, management, administration, education, health care, social assistance, arts, entertainment, recreation, lodging, government

The following charts display the number of jobs in each group and the relative share of each group of the overall employment total for 2016 and 2040.

Figure 23: Employment distribution by Sector Group, 2016 and 2040





Overall distribution of employment based on these three groups is projected to shift over time with a growing emphasis towards service jobs. Retail and basic industries will grow in overall numbers but decline slightly as a total share of employment. The shift towards a larger share of service jobs is led by expected growth in education and health-related jobs which are highly correlated with population growth. Increases in basic employment are fueled primarily by the construction industry, which will continue to recuperate jobs lost during the recession. Retail employment will grow, but at a much slower rate than the population.

APPENDIX A: Land Use Categories

MRMPO aggregates local land use types into the following categories:

Single Family includes all free-standing residential homes including mobile homes, or single attached housing including townhouses. It also includes home businesses.

Multi Family includes all attached housing with 3 or more units, or dense housing with 2 or more units. Usually the density exceeds 8 units per acre. It includes residential hotels, independent senior communities, senior housing with limited on-site medical staff, convents and monasteries.

Commercial Retail land use includes activities that include retailing merchandise, generally in small quantities directly to the general public, such as drugstores, clothing stores, and furniture stores. It also includes establishments providing services incidental to the sale of merchandise or food and drink such as pool halls, movie theatres, and amusement parks.

Commercial Services land use includes neighborhood services (usually under 100,000 square feet) including banks, auto repair and vet services. Home improvement contractors such as roofers and plumbing and heating services are included, as well as small for profit schools such as daycares, barber schools and dance schools. Commercial services may be mixed with light industrial/office.

Office includes government and professional office services such as insurance, attorneys, real estate/mortgage companies and other services that may not have as much traffic as commercial services. It also includes medical labs, as well as neighborhood scale physician, dentists, chiropractic and acupuncture offices.

Industrial land uses includes both light and heavy uses including construction yards, manufacturing parts for aircrafts, engineering or computers, and gravel or rock excavation. Small industrial uses intermingled with commercial uses may be coded as commercial. Industrial uses intermingled with office uses may be coded as office.

Medical land uses includes hospitals, health clinics, nursing homes, and senior housing with full on-site medical care.

Schools, Universities are public and private educational facilities, school administrative buildings, community colleges and major universities. Small schools for commercial profit such as dance schools or veterinarian schools and day cares will fall into commercial services.

Airports include terminal buildings, hangars, runways and heliports.

Transportation and Parking includes all road and highway rights-of-way, and parking structures and lots over 2 acres.

Irrigated Agriculture includes some rural residential, or is purely for farming or production of some kind.

Dry Rangeland refers to some rural residential, fallow agriculture, private stables, coops and corrals. It is also often designated on vacant land in rural areas.

Open Space and Recreation includes all outdoor recreational facilities including plazas, sports fields, golf courses, trails and skate parks, as well as state and federal park land, mountains, and monuments.

Natural Drainage includes major arroyos, major irrigation, canals and drains, marshlands, and wetlands.

Urban Vacant includes vacant land or abandoned structures. Minimum size is 2 acres.

Utilities includes water, sewage, landfills and electrical facilities. This encompasses incinerators, ponding sites, central refuse collection stations, pipelines, utility easements, telecommunication towers, and flood control diversion channels.

Community is a broad category; it is defined as public and quasi-public facilities that serve the community. This category includes churches, community centers and pools, fire stations, libraries, museums, cemeteries, and other non-commercial uses. In smaller communities, the town hall is also coded in this category.

KAFB designation is assigned to all land within Kirtland Air Force Base.

Mixed Use designation is appropriate for a parcel or master plan that will have multiple uses but the actual plan of what will go where is undetermined. It also pertains to live/work communities and town centers if specific uses are unknown. If the uses are known as well as their location, it is always best to code the individual uses rather than using the mixed use code.

Prisons including adult and juvenile detention facilities

Wholesale/Warehouse includes land uses that are similar to wholesale trade and are selling or arranging the purchase or sale of goods for resale. Usually this land use will be the intermediate for materials and supplies, but may also include warehouse establishments that the general public can also buy product from, such as Costco or construction supplies.