TECHNICAL EVALUATION OF THE GREENHOUSE GAS EMISSIONS REDUCTION QUANTIFICATION FOR THE SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS' SB 375 SUSTAINABLE COMMUNITIES STRATEGY

June 2016

California Environmental Protection Agency
Air Resources Board

Electronic copies of this document can be found on ARB's website at
http://www.arb.ca.gov/cc/sb375/sb375.htm

This document has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Electronic copies of this document are available for download from the Air Resources Board's Internet site at: http://www.arb.ca.gov/cc/sb375/sb375.htm. In addition, written copies may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, 1st Floor, Visitors and Environmental Services Center, Sacramento, California 95814, (916) 322-2990.

For individuals with sensory disabilities, this document is available in Braille, large print, audiocassette, or computer disk. Please contact ARB's Disability Coordinator at (916) 323-4916 by voice or through the California Relay Services at 711, to place your request for disability services. If you are a person with limited English and would like to request interpreter services, please contact ARB's Bilingual Manager at (916) 323-7053.

Contents

List of Figures

I. EXECUTIVE SUMMARY

The Sustainable Communities and Climate Protection Act of 2008 (Senate Bill 375) is intended to support the State's broader climate goals by encouraging integrated regional transportation and land use planning that reduces greenhouse gas (GHG) emissions from passenger vehicle use. The metropolitan planning organizations (MPOs) of California develop regional Sustainable Communities Strategies (SCS) as part of the Regional Transportation Plan (RTP). These SCSs demonstrate whether the MPO can meet the per capita passenger vehicle-related GHG emissions targets (targets) for 2020 and 2035 set by the California Air Resources Board (ARB or Board).

The Southern California Association of Governments (SCAG) is the largest MPO in California, covering six counties in the Southern California region. It is the transportation planning agency responsible for developing and implementing a vision for the region's future. It does this by coordinating transportation planning and growth management efforts among the local jurisdictions. SCAG contains almost 50 percent of the State's total population, with 18.3 million residents. The region is unique based on its size and diversity with 191 cities covering more than 38,000 square miles encompassing coastline, inland valleys, mountain ranges, and expansive deserts. The region is a global center for entertainment, commerce, tourism, and international trade. Both the Port of Los Angeles and the Port of Long Beach are located in the SCAG region, which together are the largest container port complex in the United States.

For the SCAG region, the Board set targets of 8 percent per capita reduction in 2020 and 13 percent per capita reduction in 2035, from a base year of 2005. In April 2012, SCAG adopted its first RTP/SCS and the Board determined that the SCS, if implemented, would achieve the 2020 and 2035 GHG emissions reduction targets.

SCAG has worked over the past four years to begin implementing key elements of its 2012 SCS while simultaneously developing the second SCS, which was adopted on April 7, 2016. *The 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy: A Plan for Mobility, Accessibility, Sustainability, and a High Quality of Life* continues to emphasize the key land use and transportation strategies in the first SCS that support a more sustainable future for the SCAG region. SCAG anticipates new growth will occur within existing urban boundaries with higher density development instead of sprawling outward. The 2016 SCS continues on the course set by the 2012 SCS to direct transportation investments within existing urbanized areas to support a more compact urban form. It includes an extensive regional bus and bus rapid transit (BRT) system, improved commuter and light rail service, an expanded regional bicycle network, improved pedestrian infrastructure, dedicated highway lanes for carpool and express buses, and several transportation demand management programs that reduce the number of vehicle trips.

The outcomes of this plan by 2035 include an increase in the number of homes and jobs near transit, a more diverse housing stock, and economic benefits due to reduced congestion and new or improved transportation infrastructure. SCAG's quantification of GHG emissions reductions from the 2016 SCS indicates that the plan would result in per capita emissions reductions of 8 percent by 2020 and 18 percent by 2035 from a base year of 2005.

The modeling tools are key components for analyzing the outcomes of the plan and also help to inform the project selection process. SCAG used the same modeling system for both its 2012 RTP/SCS and its 2016 RTP/SCS which includes the region's travel demand model, off-mode quantification tools, and EMFAC 2014. The travel demand model is a trip based model that relies on population, employment, and future planning assumptions to estimate travel demand. Refinements to the travel demand model since 2012 include new model validation tests, new model sensitivity tests, and some new data inputs and assumptions. SCAG also uses off-model adjustment tools to estimate additional GHG emissions reductions from innovative strategies, such as neighborhood electric vehicles, to which the travel model is not responsive. The Scenario Planning Model (SPM), one of SCAG's off-model tools, was used for the first time for the 2016 RTP/SCS to analyze the benefits of active transportation investments and land use scenarios.

SB 375 directs the Board to accept or reject the determination of each MPO that its SCS would, if implemented, achieve the region's GHG emissions reduction targets for 2020 and 2035. This report reflects ARB staff's technical evaluation of SCAG's 2016 RTP/SCS and describes the methods used to evaluate the MPO's GHG quantification. Based on all the evidence, including the region's travel model documentation, model validation report, modeling assumptions, model inputs and outputs, the SCS strategies, and the performance indicators, ARB staff concludes that SCAG's 2016 RTP/SCS would, if implemented, meet the targets of 8 and 13 percent.

II. IMPLEMENTATION OF SCAG'S FIRST SCS

The goals of SCAG's first RTP/SCS include ensuring the region's long-term economic competitiveness and improving quality of life for current and future generations. The region is working to reverse air pollution trends, increase investment in alternatives to single occupancy auto use, create greater opportunities for affordable housing and housing diversity, and strengthen the economy.

Achievement of the forecasted GHG reductions and other regional benefits hinges on local and regional actions to implement the policies in the RTP/SCS. There are numerous examples of such actions over the past four years which demonstrate the region's commitment to the planning vision in the 2012 RTP/SCS. Since the adoption of the 2012 RTP/SCS, the region has completed multiple transportation projects, provided funding for sustainable community planning, and developed tools to assist local jurisdictions with SCS implementation. Some examples are highlighted below.

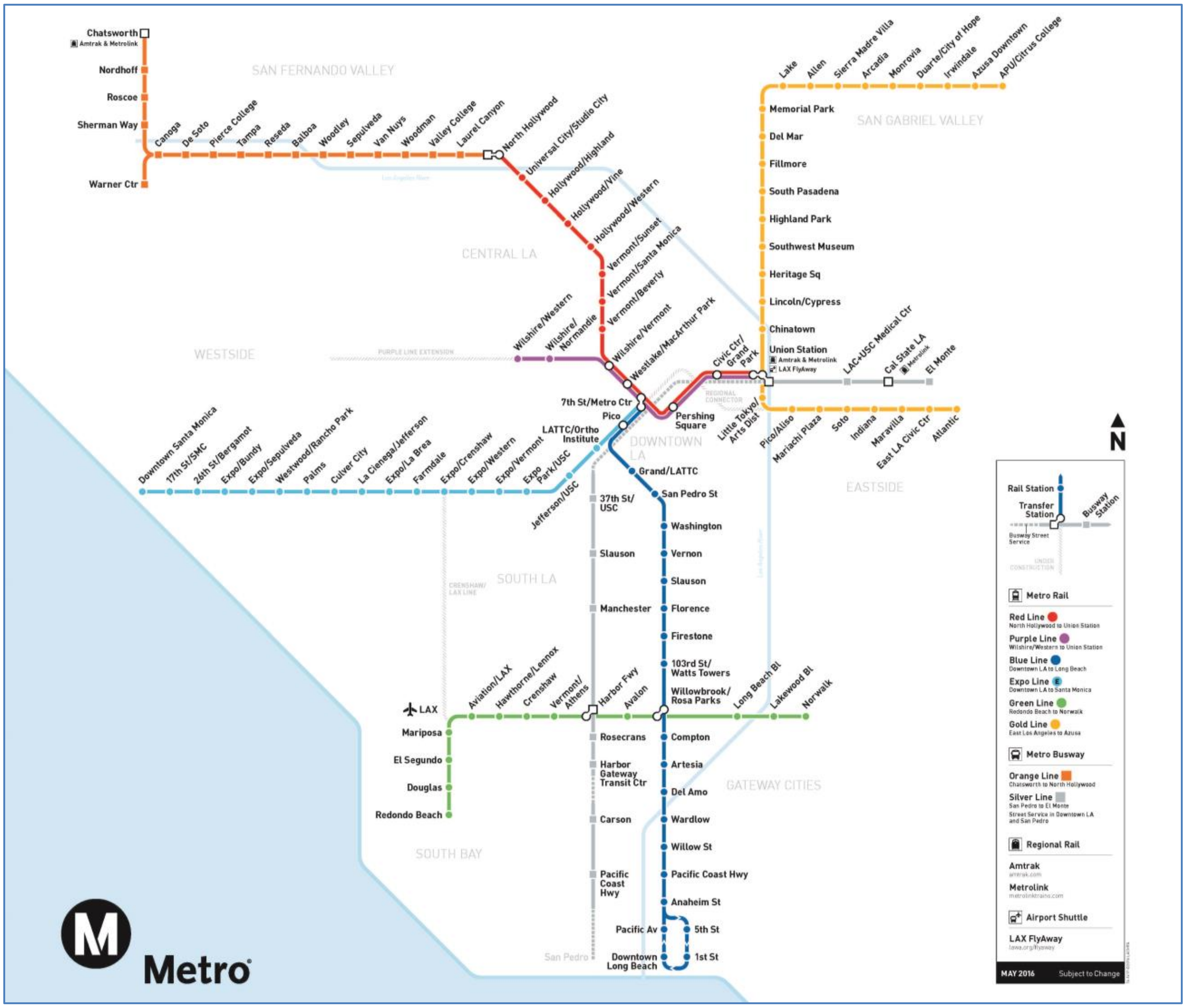
A. Enhancing the Multi-Modal System

Many transportation projects completed since the adoption of the 2012 RTP/SCS increase the choice, efficiency, and safety of travel in the SCAG region.

Transit

Transit service throughout the region has improved since 2012, primarily due to an increase in rail service. Los Angeles County Metropolitan Transportation Authority (LA Metro), the largest service provider in the region, completed several light rail projects, including the Orange Line Extension, the Expo Line Extension (Phase I and II), and the Gold Line Eastside Extension in Los Angeles County. Three major rail projects are also currently under construction including the Crenshaw/LAX Line, Purple Line Extension, and the Regional Connector in Los Angeles County (Figure 1). In addition, LA Metro is currently seeking funding for the Gold Line Foothill Extension further east from Azusa to Montclair.

Figure 1: LA Metro Rail Map (May 2016)



Source: http://media.metro.net/riding_metro/maps/images/rail_map.pdf

For passenger rail, the Perris Valley Line in Riverside County was completed in early 2016. This Metrolink line connects downtown Los Angeles and downtown Riverside, the first extension of Metrolink service since 1994. In addition, a major Amtrak route is now locally managed by the same governing board as Metrolink. This partnership will help to better manage and integrate passenger rail service in the SCAG region.

Two transportation centers including the Anaheim Regional Transportation Intermodal Center (ARTIC) in Orange County and the Burbank Bob Hope Airport Regional Intermodal Transportation Center (RITC) in Los Angeles County have been completed since 2012. ARTIC provides connections with Amtrak, Metrolink, Greyhound Bus, Megabus, and local transit providers. RITC is the first direct rail-to-terminal connection in Southern California and connects the Burbank Airport with Metrolink, Amtrak, and local transit. Both transportation centers will also have future connections with California High-Speed Rail (HSR).


Source: http://www.articinfo.com/news-events/image-video-library
Source: http://www.scpr.org/news/2015/07/15/53138/trains-in-santa-monica-expo-line-begins-tests-near/

Active Transportation

Local jurisdictions joined together to prepare multi-jurisdictional bicycle master plans to improve connectivity throughout the region, particularly in the South Bay and the San Gabriel Valley subregions. SCAG developed the Bicycle Route 66 Concept Plan to improve awareness of the route throughout the region and State. SCAG also developed an active transportation database, the Bike County Data Clearinghouse[1], with LA Metro and UCLA's Luskin School of Public Affairs to assist local jurisdictions, non-profit organizations, community groups, and other stakeholders in the preparation of active transportation plans and programs. SCAG estimates that 112 local jurisdictions or counties currently have active transportation plans.

Planning efforts to improve first mile/last mile access to transit are also underway since the 2012 RTP/SCS. The San Bernardino Association of Governments, LA Metro, and the Orange County Transportation Authority (OCTA) have each completed studies[2] on first/last mile strategies for their subregions. The strategies are intended to better coordinate

[1] http://www.bikecounts.luskin.ucla.edu/
[2] SCAG 2016 RTP/SCS Active Transportation Appendix, page 24

infrastructure investments to extend the reach of transit, improve safety, and incorporate innovative solutions such as bike-share to encourage transit use. SCAG is currently working with Riverside Transit Agency to develop a first mile/last mile study[3] .

An active transportation encouragement program, known as the “Go Human” campaign[4], was also launched in 2015. This is a joint effort between SCAG and all six County Health Departments and six County Transportation Commissions. The campaign includes billboard and bus advertising to promote traffic safety as well as the development of resources and toolkits that active transportation stakeholders can use to encourage walking and biking in their communities.

HOV and Express Lane Improvements

Major roadway improvements since 2012 include the completion of almost 40 HOV lane miles on Interstates 5, 10, 215, 405, and 605 and State Routes 57 and 91. This includes the Interstate 215 HOV project in Riverside and San Bernardino Counties that closed an eight mile HOV gap, and the West County Connector Project in Orange County with new HOV connections between Interstate 405, 605, and State Route 22. These projects have improved access, closed critical system gaps, and reduced congestion throughout the region.

The region is also developing an express lane network with three routes either completed since 2012 or currently under construction. A one-year express lane demonstration project in Los Angeles County along Interstates 10 and 110 was made permanent in 2014.

Pricing and Alternative Revenue Generation

The 10 and 110 express lane project[5] introduced congestion pricing to the region by converting HOV lanes to High Occupancy Toll (HOT) lanes. Solo drivers pay a fee to use the express lanes and vehicles with three or more passengers either ride for free or receive a discounted rate. Similar express lanes are also under construction on State Route 91 between Los Angeles and Riverside County. The express lane network is intended to better utilize capacity, improve travel time, and encourage carpooling. Revenue generated from priced lanes can also be used as investment in system construction and improvement.

[3] SCAG 2016 RTP/SCS Active Transportation Appendix, page 24
[4] http://gohumansocal.org/Pages/Home.aspx
[5] https://www.metroexpresslanes.net/en/about/about.shtml

Transportation Demand Management/Transportation System Management

Transportation demand management (TDM) and transportation system management (TSM) help to maximize capacity and efficiency of the existing transportation system and facilities. This includes technology, ridesharing, value pricing, telecommuting, and better integrated transportation modes. TDM strategies are generally aimed at reducing SOV travel by encouraging behavior shifts to carpooling or vanpooling or reducing peak period travel. All six counties in the SCAG region currently have vanpool programs, which together subsidize more than 2,000 vanpools as of 2015. Additionally, Caltrans, LA Metro, and UC Berkeley implemented an Integrated Corridor Management pilot program on Interstate 210 to identify ways to better integrate arterials, highways, transit, and parking systems using TSM strategies. Arterial signal synchronization projects have also been completed on a number of arterials throughout the region to improve traffic flow. In 2015, Metrolink was the first operator in the nation to implement a GPS-based safety technology capable of preventing train-to-train collisions and derailment.

Electric Vehicles

Neighborhood Electric Vehicles (NEVs) can provide an alternative to internal combustion vehicles especially for short trips and are particularly useful in communities where expansion of transit service is not feasible. Several jurisdictions are currently developing Neighborhood Electric Vehicle[6] policies and pursuing funding for NEV infrastructure. Examples include the South Bay Cities Council of Governments Pilot Program, the City of Huntington Beach NEV Plan Sustainability Planning Grant, and the Coachella Valley Association of Governments CV Link Multi-Modal Path Project.

Source: http://www.plugincars.com/neighborhood-electric-vehicle-margins-127231.html

In 2011, the South Coast Air Quality Management District and SCAG received funding from the U.S. Department of Energy to prepare a plug-in electric vehicle (PEV) readiness plan for the region. SCAG's 2012 PEV Readiness Plan and associated Southern California Plug-in Electric Vehicle Atlas will help prioritize PEV efforts for local jurisdictions. Two subregions also received funding – the South Bay Cities Council of

[6] Neighborhood Electric Vehicle (NEV) is a federally designated class of roadway passenger vehicle usually designed to have a top speed of 25 miles per hour that can be operated on any public roadway with a posted speed limit of 35 miles per hour or lower.

Governments and Western Riverside Council of Governments – from the California Energy Commission to prepare PEV Readiness plans, which were completed in 2013.

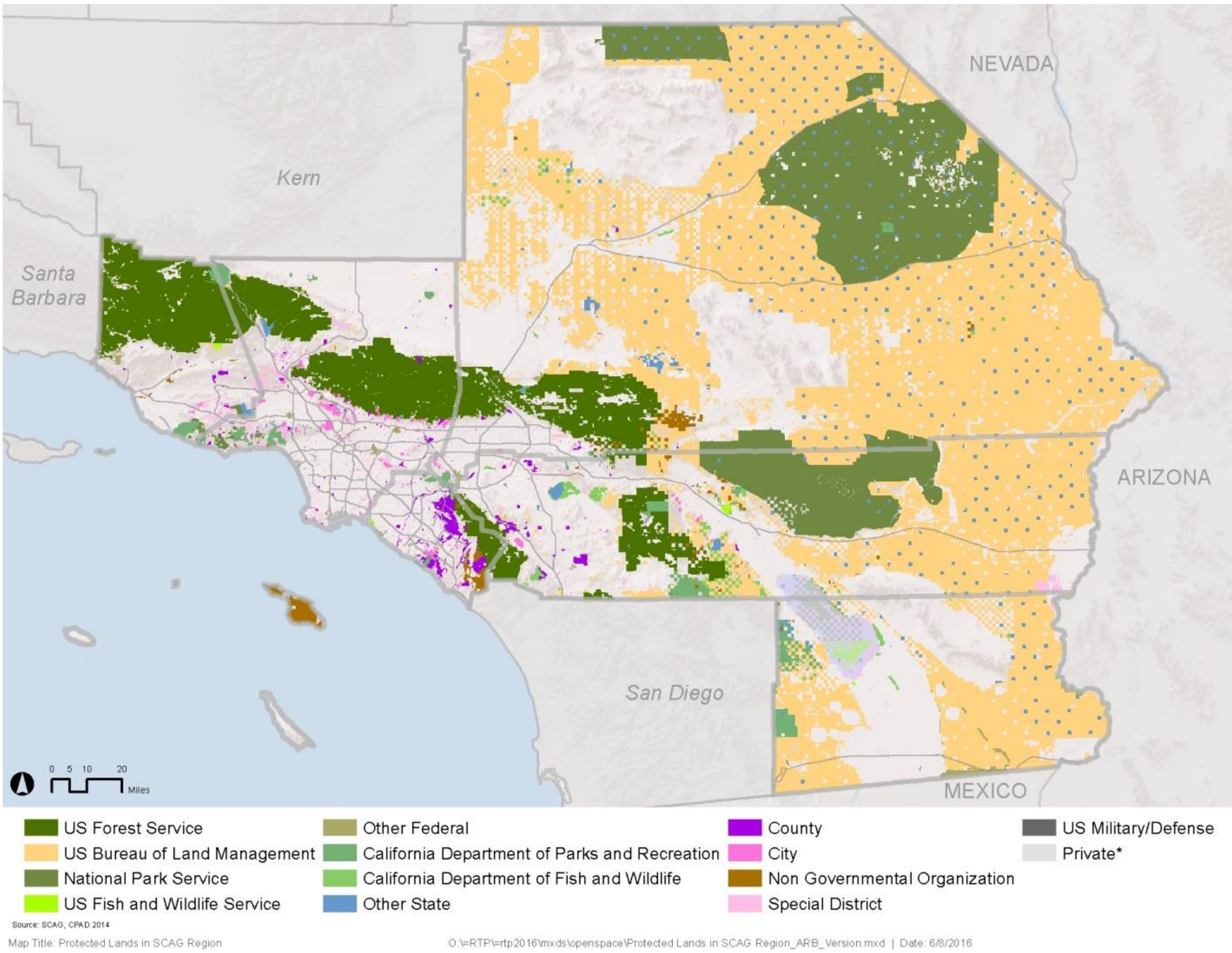
B. Encouraging Sustainable Land Use

Since the 2012 RTP/SCS, local jurisdictions have been working to make local land use plans more consistent with the goals of the RTP/SCS. In early 2014, SCAG conducted a survey of local jurisdictions to better understand initial implementation of the 2012 RTP/SCS. SCAG reports that about 40 General Plans have been updated since 2012 and another 38 General Plans are in the process of being updated. Jurisdictions have also completed new specific plans for town centers and Transit Oriented Development (TOD). Many of the General Plan updates include TOD elements and infill development policies. Several jurisdictions have also adopted climate action plans. Almost every city in the SCAG region, 189 out of 191, has adopted policies, plans, or programs that encourage sustainable land use.

Land Conservation

To further the goal of the 2012 RTP/SCS to conserve open space and natural lands, SCAG developed an Open Space Conservation Working Group comprised of local jurisdictions, County Transportation Commissions, non-profit organizations and stakeholders to guide planning efforts for the 2016 SCS. The result of this effort is a Conservation Framework and Assessment and a regional database which identifies key information and data gaps pertaining to natural resources in the region. The Conservation Framework is the basis for the recommended open space conservation policies in the 2016 RTP/SCS and provides the foundation for an Open Space Conservation Plan and regional conservation program that SCAG is currently developing. Figure 2 shows the open space and conservation areas within the SCAG region. Understanding the location and nature of these conservation areas, which includes critical habitat areas, can help guide future growth and development away from open space into existing suburban and urban areas.

Figure 2: Open Space and Conservation Lands in the SCAG Region



Source: SCAG 2016 RTP/SCS Natural and Farm Lands Appendix, Exhibit 3

Public Health

As a result of the 2012 RTP/SCS development process, SCAG received strong public support and direction from its governing board to further incorporate public health in the 2016 SCS planning process. SCAG established a Public Health Subcommittee and a Public Health Working Group, and prepared a Public Health Work Program. SCAG is also developing a tool that it and local governments can use to identify health co-benefits and evaluate public health outcomes of different planning scenarios. As a result of these efforts, land use strategies and transportation investments that increase neighborhood walkability, active transportation opportunities, and green space are reflected in the 2016 RTP/SCS. Riverside County has been a leader in addressing public health outcomes at the local level by forming a health coalition and preparing a Community Health Improvement Plan[7].

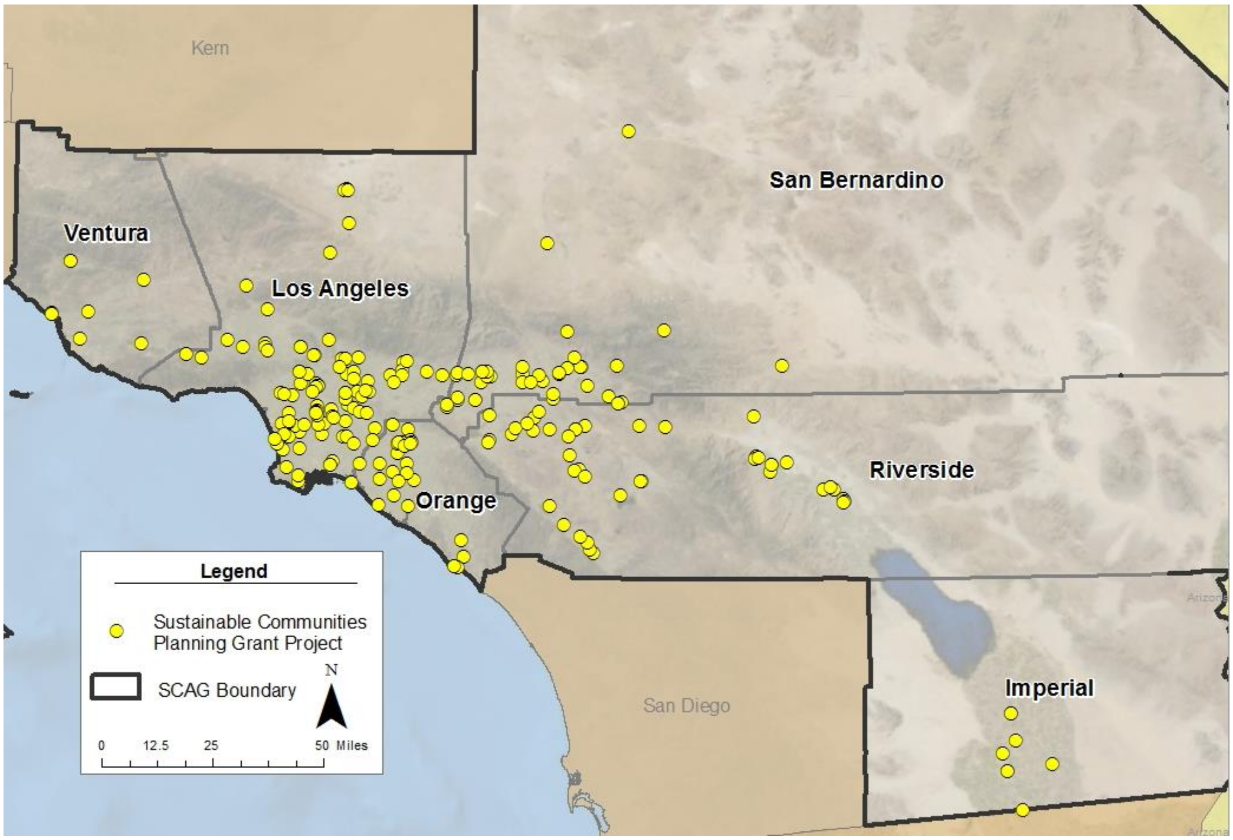
C. Local Funding Assistance

SCAG supports local implementation of the SCS through an MPO-funded grant program. Originally established in 2005 under the title "Compass Blueprint Grant Program," the program was rebranded in 2012 as the "Sustainable Communities Planning Grant Program." In FY2013-2014, SCAG awarded $10 million in grant funding for 75 projects selected for their potential to integrate land use and transportation, improve active transportation, and help conserve natural resources[8]. The diverse group of projects includes local climate action plans, corridor studies, transit-oriented development (TOD) plans, community revitalization strategies, and active transportation plans and programs. SCAG selected projects from each county in both urban and rural areas. By the end of 2016, SCAG anticipates local jurisdictions will have completed a cumulative total of over 200 projects (Figure 3) with financial assistance from this grant program.

[7] http://www.healthyriversidecounty.org/

[8] http://sustain.scag.ca.gov/Pages/Grants%20and%20Local%20Assistance/GrantsLocalAssistance.aspx

Figure 3: SCAG Sustainable Communities Planning Grant Projects



Source: ARB and SCAG

D. On-Going Challenges and Opportunities

As the region moves forward in developing more sustainable communities it will also be faced with a number of challenges and opportunities that will influence the region's priorities and future planning to improve public health, mobility, and quality of life.

Challenges

The median age of the region's population is projected to rise. Today people over the age of 65 represent 12 percent of the total population, and by 2040 it will increase to 18 percent. As this shift occurs the percentage share of the younger, working-age population is projected to fall and the region may face a labor shortage that would impact economic growth and tax revenues. The region will continue to struggle with housing affordability and issues of displacement.

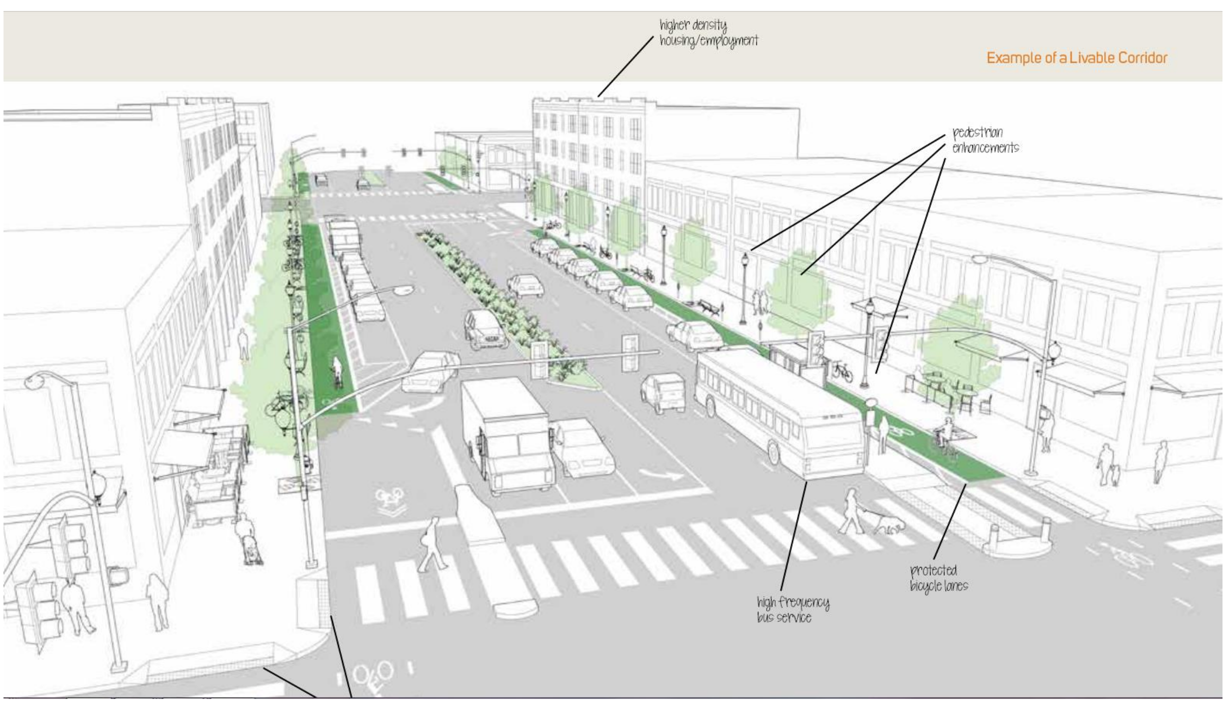
An on-going challenge for the transportation system is the need for maintenance and rehabilitation. The state highway system has deteriorated over the years with 12 to 20 percent of the lanes (depending on county) considered structurally distressed. Freight growth in the region is also placing added stress on the highway system. These needs are outpacing available revenue, on top of a system that has been underfunded for the last several decades. Revenues from the gas tax, an important source of transportation funding, are actually declining as automobiles become more fuel efficient and some switch entirely from gasoline to electricity. It is imperative for the State and region to develop innovative funding mechanisms to fill in the gap.

Climate change and public health and safety concerns are also major challenges in the SCAG region. Extreme weather events, drought, wildfires, declining snowpack, and the threat of rising sea level will impact the region in various ways including the placement and type of future development. Many of the region's residents also suffer from chronic diseases such as heart disease, respiratory illnesses, obesity and diabetes, which are related to poor air quality and physical inactivity.

Opportunities

These challenges are not insurmountable. While much of the of the region's communities are suburban, auto-oriented neighborhoods, the younger generation is showing a preference for more transit-oriented, urban communities and it is anticipated that the older generation may trend this way as well. This change in attitude may accelerate the support for infill development, complete streets, enhanced mobility options, conservation of natural lands, and more livable corridors (Figure 4). Improved accessibility for everyone in the region translates to opportunities for economic growth.

Figure 4: Example of a Livable Corridor



Source: SCAG 2016 RTP/SCS, page 81

Technology is also influencing travel behavior with the emergence of fully electric cars, car sharing, neighborhood electric vehicles, and real-time traveler information. It's important to track these changes to ensure there are no unintended consequences, but these advancements could yield efficiency improvements and accessibility. And nationally a shift is occurring to prioritize accessibility for all communities and a movement to consider performance metrics that value sustainable transportation systems.

> *"The notions of who's in or who's out are still part of the build environment, and we can do something about it"*
> – *Anthony Foxx, Secretary of Transportation*

III. REGIONAL LAND USE AND TRANSPORTATION TRENDS

The SCAG region covers six counties: Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura, and accounts for almost 50 percent of the State's population. The majority of SCAG residents, almost 55 percent, live in Los Angeles County, which is the most populous county in the both the State and the SCAG region. The region is also home to the State's largest county in terms of land area, San Bernardino. Only 21 percent of the land within the region is suitable for development and of this, more than half is already fully developed.

A. Land Use

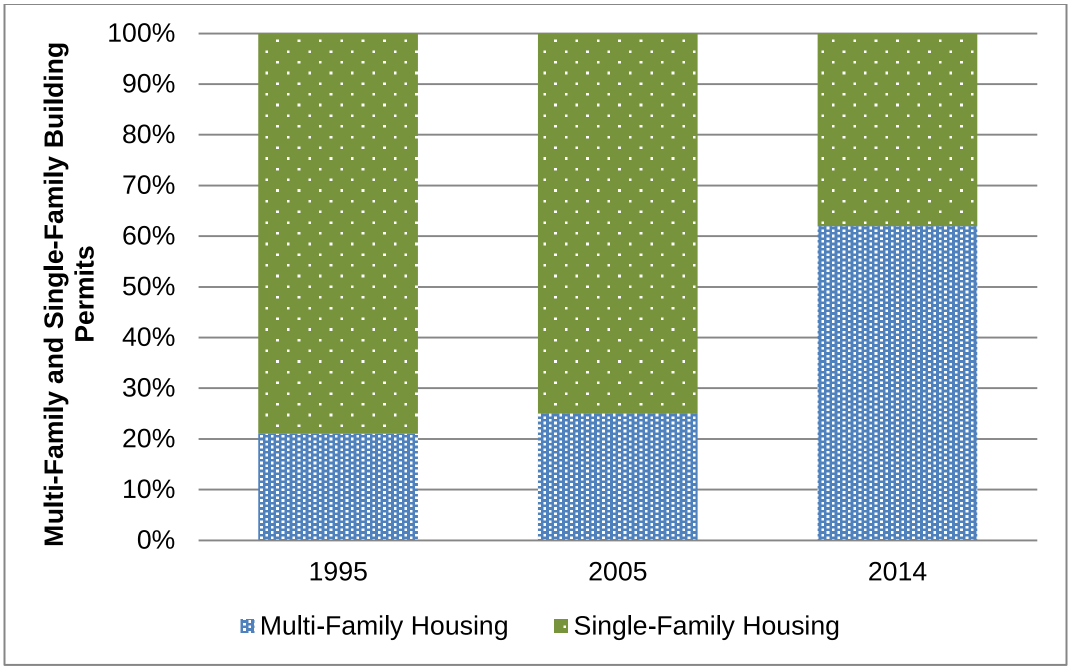
Growth over the last 20 years has increased steadily from a total population of 14.6 million in 1990, to 16.5 million in 2000, and 18.3 million in 2012. Rapid growth and suburbanization occurred between 1910 and 1960 with a population growth rate of 22 percent for the 50-year time period. Since 1960, growth has occurred at a much slower rate at 3 percent between 1960 and 1990 and 1.2 percent between 1990 and 2010. Although the regional growth rate has stabilized, urbanization and suburbanization of the region has continued especially in Orange, Riverside, and San Bernardino counties.

Since 1970, California's homeownership has averaged about 10 percent lower than that of the nation as a whole. A chief reason is the high cost of housing in California, relative to the rest of the nation. Between 1970 and 2005, homeownership rates were increasing at a steady pace for the region. In the last ten years, homeownership rates have declined primarily due to the recession of 2008. Residents in the SCAG region have moved further from metropolitan centers in search of more affordable housing.

Over half of the existing housing stock is single-family homes.

The majority of residential development has been single-family homes, which represents over half (55 percent) of the existing housing stock. Over the last several decades, there has been a general increase in the number of permits for multi-family housing as depicted in Figure 5 below. This trend reflects the increase in demand for affordable and multi-family housing in the region.

Figure 5: Multi-Family and Single-Family Building Permits Issued

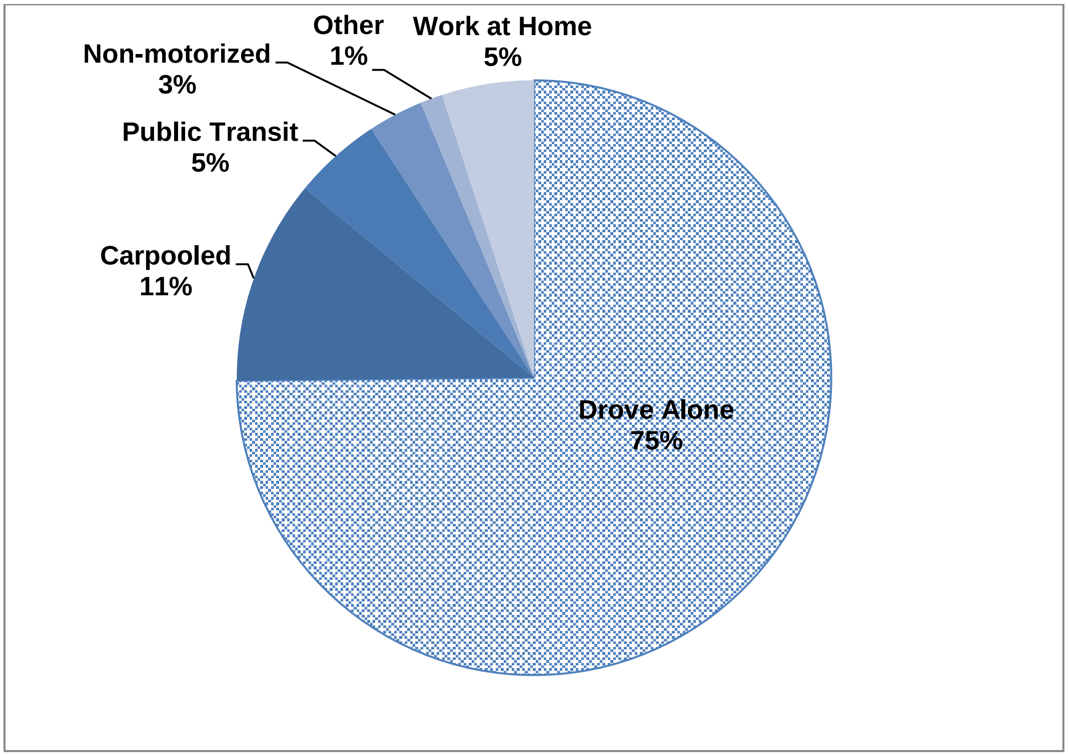


Source: SCAG 2016 RTP/SCS, Figure 2.1
Single-Family housing units include detached, semi-detached, row house and town house units. Multi-family housing includes duplexes, 3-4 unit structures, and apartment type structures with five units or more.

B. Transportation

SCAG's transportation network is robust and includes roadways, rail, bus, Bus Rapid Transit (BRT), demand response, and bicycle and pedestrian infrastructure. The majority of trips in the region have historically been taken by automobile, either in single occupant vehicles (SOV) or as shared ride trips in high occupant vehicles (HOV). Figure 6 illustrates the mode split of trips for the SCAG region during the period from 2009 to 2014 for work-based trips. This chart shows that driving alone is the predominant mode accounting for about 75 percent of all trips. Mode share often reflects the choices travelers have based on existing land use and transportation infrastructure. SCAG's efforts to implement the SCS provide opportunities for residents to make different mode choices in the future.

Figure 6: SCAG Mode Share for Worked-Based Trips (2014)



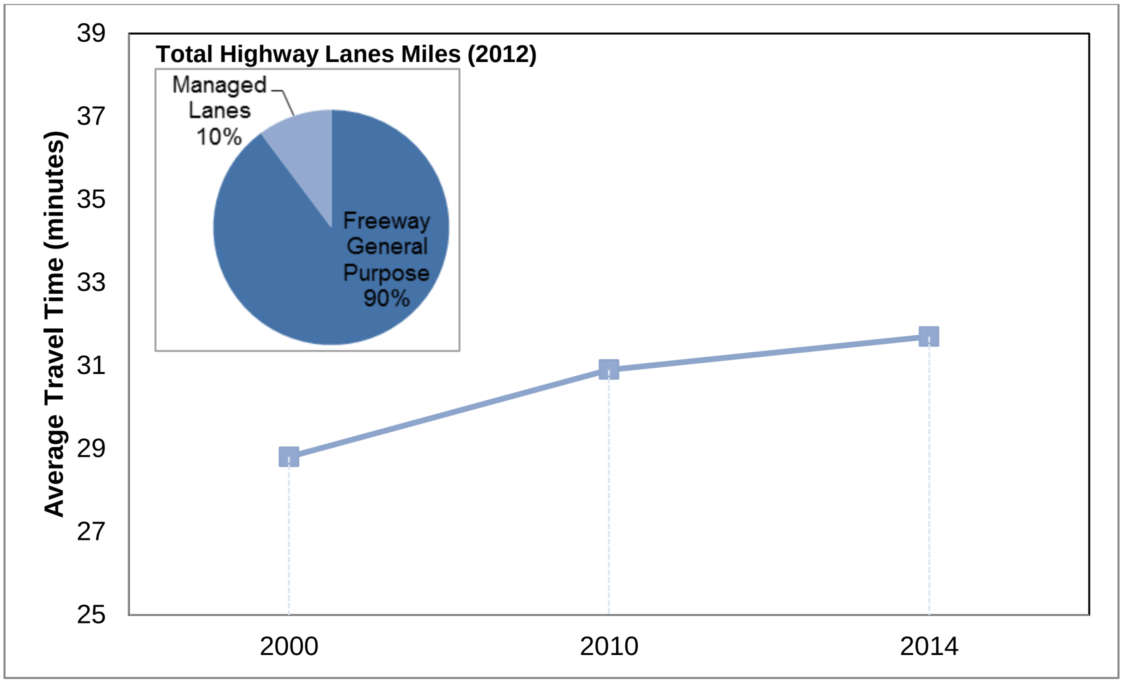
Source: U.S. Census, American Community Survey

Roads

The SCAG region has over 11,000 lane miles of freeway and general purpose lanes and almost 1,300 lane miles of managed lanes (HOV, HOT, or tolled) as of 2012 (Figure 7). Since the 2012 RTP/SCS, SCAG has added less than 100 lane miles of freeway or general purpose lanes. Traffic congestion continues to be a major challenge for the SCAG region with increased traffic delays. As a result of congestion, a less than ideal jobs/housing balance, and other contributing factors, average travel time has increased almost three minutes since 2000 (Figure 7).

Due to congestion, average travel time has increased since 2000.

Figure 7: Total Highway Lanes (2012) and Average Travel Time (2000-2014)



Average Travel Time Source: SCAG Local Profile Regional Data
Total Highway Lanes Source: SCAG Modeling Data Table (Appendix B)

Transit

Transit in the SCAG region includes light rail, heavy rail (subway), commuter rail, fixed-route bus lines, circulators[9], express and rapid buses, BRT, and demand response. The SCAG region is home to almost 70 fixed route transit operators, including LA Metro, the nation's third largest transit operator for passenger trips[10]. There are also over 100 specialized service providers, including community circulators, ferries, dial-a-ride, and paratransit. Several transit agencies provide service outside the SCAG region with trips to the counties of Santa Barbara, San Diego, Kern; the States of Nevada and Arizona; and destinations such as Mammoth Lakes and Yosemite National Park.

There are nearly 70 fixed route transit operators and over 100 specialized transit providers in the region.

Over the last ten years, rail service in the region has grown by 63 percent and demand response service has increased 29 percent. Fixed route bus service has declined slightly by 3 percent over the same time period. Many of the region's transit providers

[9] Circulators are typically defined as a bus or trolley confined to a specific locale, such as a downtown area or suburban neighborhood, with connections to major traffic corridors.
[10] American Public Transportation Association: 2015 Public Transportation Fact Book, p8

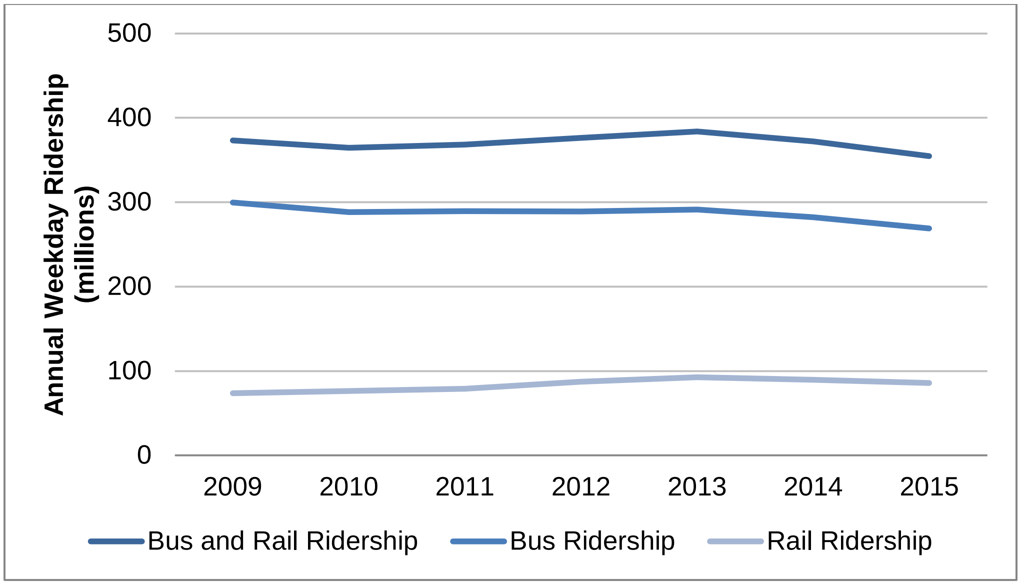
are still recovering from service cuts made during the recession. Several transit providers are looking closely at the recent decrease in ridership and considering strategies that will return ridership to pre-recession levels. In addition, low fuel prices may also contribute to an increase in driving and a decrease in transit use[11].

Metrolink provides commuter rail service within the region with seven routes and 55 stations. It has experienced a slight increase in annual ridership in the last four years, from 11.6 million riders in 2012 to 11.8 million riders in 2016. One of the challenges for passenger rail expansion is that more than half the commuter and intercity rail operate on one track that is owned by multiple agencies. This can lead to train delays, reduced speeds, and low service frequencies. As of 2015, Amtrak's Pacific Surfliner is now managed by the same governing board as Metrolink, which should help address some of these issues. In addition, in March 2016, Metrolink adopted a 10-Year Strategic Plan and a 5-Year Short-Range Transit Plan that includes a set of strategies to address system deficiencies as well as retain and increase ridership.

The majority (about 77 percent) of total transit trips for the region occur in Los Angeles County. There are 13 municipal operators and two joint power authorities, in addition to LA Metro, that operate within the county. LA Metro has the largest territory and operates light rail, heavy rail, bus rapid transit, and fixed route bus services. Service for LA Metro rail has grown in the last several years, which can be partially attributed to completion in 2016 of the Gold Line Eastside Extension connecting Los Angeles to Azusa, about 30 miles to the east. As shown in Figure 8, annual weekday rail ridership has increased in the last five years from about 76 million riders in 2010 to almost 86 million in 2015. Annual weekday bus ridership has decreased over the same time period, from about 288 million riders in 2010 to 269 million in 2015. LA Metro adopted a Short Range Transportation Plan in 2014 that guides the region toward long-term goals for growth and public transportation expansion.

[11] http://www.umich.edu/~umtriswt/EDI_values.html

Figure 8: LA Metro Annual Weekday Ridership (2009-2015)

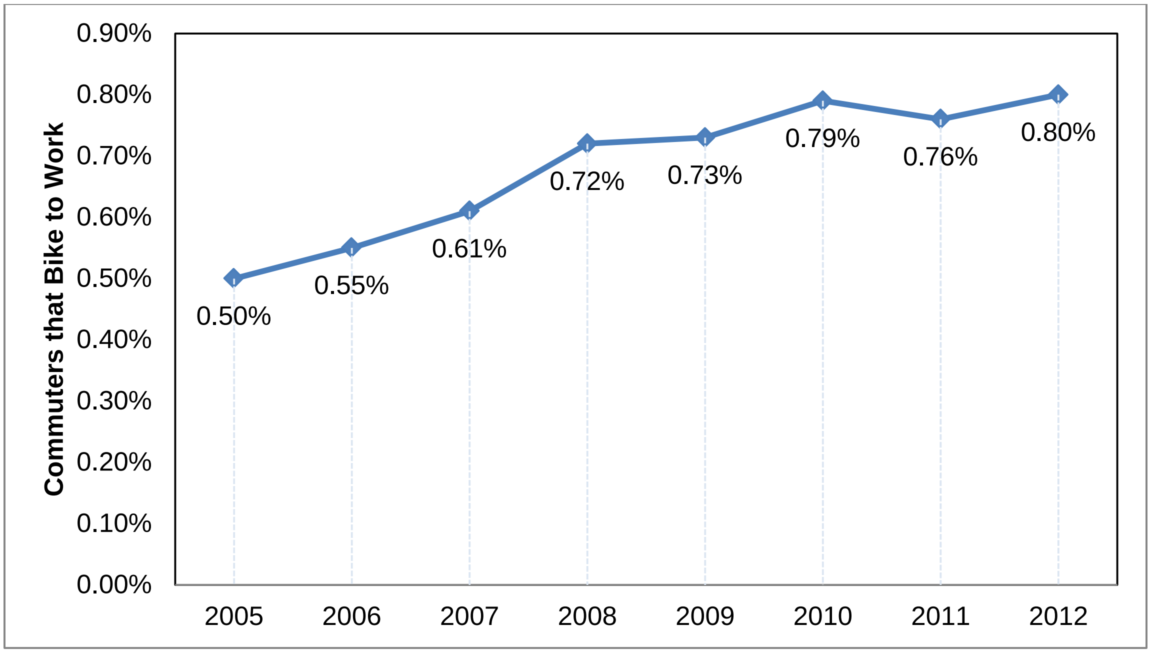


Source: http://isotp.metro.net/MetroRidership/Index.aspx

Active Transportation

Based on the California Household Travel Survey, SCAG estimates that the highest percentage of walking and biking occurs in urban areas, where the mode share can reach up to 44 percent. Currently, the SCAG region has almost 4,000 bikeway miles with about 500 miles built since 2012. The majority of the bikeways are located in Los Angeles County, followed by Riverside and Orange County. As mentioned earlier, there are approximately 112 city and county active transportation plans in the region and another 42 jurisdictions are currently preparing plans. In addition, 80 jurisdictions have adopted or are preparing local pedestrian plans. Figure 9 shows that there has been a slight increase between 2005 and 2012 in the number of individuals that commute to work by bicycle. This represents a 30 percent increase in biking to work over the seven year period.

Figure 9: Commute to Work by Bike (2005-2012)



Source: SCAG 2016 RTP/SCS Active Transportation Appendix, page 19
Original Source: American Community Survey (3 Yr Average) 2005-2012

Electric Vehicles

Electric vehicles have also been gaining popularity in the SCAG region. Fully electric vehicles, like the Nissan Leaf and Chevrolet Spark, rely completely on electric batteries. Many of these models became available after 2010. According to the Department of Motor Vehicles (DMV), in 2010 there were about 180 fully electric vehicles registered in the SCAG region, which has increased to over 32,000 registered in 2015. The number of partial-electric vehicles has also increased from about 150 registered in 2010 to almost 45,000 registered in 2015. Together, there are over 77,000 fully electric or partial-electric vehicles registered in the SCAG region as of 2015. This represents nearly 40 percent of the fully electric or partial-electric vehicle population in the state.[12]

C. Emerging Trends

Demographics

SCAG predicts the population will continue to increase, although at a slower pace[13] than previously and the demographics and socioeconomic characteristics of the region are changing. Population in the SCAG region is anticipated to grow from 18.3 million people

[12] http://www.pevcollaborative.org/sites/all/themes/pev/files/5_mayl_PEV_cumulative.pdf
[13] The expected population growth rate is 0.7 percent. The growth rate between 2000 and 2010 was 0.9 percent.

in 2012 to 22.1 million by 2040, an increase of 21 percent. The region will add an additional 1.5 million households and 2.5 million jobs during the same time period. The Baby Boomer generation (those born between 1944 and 1964) and the Millennial generation (those born between 1980 and 2000) will influence the labor force and household characteristics. The preference for single-family homes is anticipated to shift as the generation ages and the number of households without children (or children at home) increases. The region will also become more racially and ethnically diverse. These demographic shifts will impact the location and demand for housing types as well as the demand for more varied transportation options.

By 2040, the region's population will reach 22.1 million, a 21 percent increase from 2012.

Ridesharing/TDM

The emergence of private transportation companies and technology has the potential to change travel behavior throughout the region. Car sharing businesses like Car2Go and Zipcar that offer short-term car rentals are becoming firmly established. They offer flexibility and more vehicle choices to accommodate household needs. Transportation companies, including Lyft and Uber, provide on-demand transportation services as well as ridesharing opportunities. Newer ridesourcing services like Lyft Line, may also increase transportation efficiency and reduce VMT by picking up multiple riders headed in the same direction. These trends may influence household auto ownership too.

About 5 percent of workers, or about 400,000 people, telecommute.

Changing work place policies, including telecommuting and flexible work schedules, may also influence travel behavior. According to the U.S. Census, currently about 5 percent of workers telecommute in the SCAG region, which has increased by about 1 percent in the last five years. Flexible work schedules, where employees flex hours to reduce travel during peak periods, are increasingly popular. As the region shifts to more tech-based jobs that are conducive to telecommuting and as employers increase remote access ability, these trends are expected to continue to increase.

Economy

The region's economy is substantially driven by health care, educational services, retail trade, and manufacturing. As of November 2015, the region's unemployment rate was 5.6 percent, which is close to the pre-recession level of 5.5 percent in 2007, and down significantly from 12.1 percent in 2010. The total number of jobs lost during the recession has mostly been recovered. However, many of these recovered jobs are in lower paying sectors[14].

The Port of Los Angeles and Port of Long Beach, the largest port complex in the United States, handled about 117 million metric tons of imports/exports in 2014. The region has almost 1.2 billion square feet of warehouse and distribution centers along goods movement corridors to help distribute goods throughout the United States[15]. Consumer based product demand is anticipated to increase which could lead to strain on the existing goods movement system. Container volume for the Port of Los Angeles and Port of Long Beach combined, is anticipated to increase from 14 million in 2010 to 36 million by 2035[16].

---

[14] http://economy.scag.ca.gov/Economy%20site%20document%20library/2015economicsummit_presentation_SCAGRegionEconomicUpdate.pdf

[15] http://economy.scag.ca.gov/Economy%20site%20document%20library/2015economicsummit_presentation_The2016RTPSCS.pdf

[16] 2016 RTP/SCS Goods Movement Appendix, page 9

IV. 2016 SCS DEVELOPMENT AND STRATEGIES

A critical component of developing the SCS is the participation of local government partners. SCAG used a bottom-up planning process that encouraged input from local government jurisdictions, County Transportation Commissions, and key stakeholders in the region. This bottom-up process involved one-on-one meetings to obtain input and feedback on the draft growth forecast and land use data. SCAG started the local input process in March of 2013 to develop the forecasts for future land use, population, household, and employment which are the foundation for the RTP/SCS scenarios.

SCAG conducted 195 meetings with local jurisdictions as part of the bottom-up, local input process.

The alternative planning scenarios developed early in the planning process were based on the same nine goals of the 2012 RTP/SCS, and eight guiding policies, two of which were added to address emerging technology and transportation investments focused on sustainability. In general, these goals include:

- improving regional economic development and competitiveness
- maximizing mobility and accessibility
- ensuring travel safety and reliability
- preserving the existing transportation system
- maximizing productivity
- protecting the environment and health of residents
- encouraging energy efficiency
- encouraging land use patterns to facilitate transit and active transportation
- maximizing security of the transportation system

The SCAG region faced several challenges in meeting the RTP/SCS goals including a slower growth rate, aging population, smaller workforce, high housing costs, and predominately suburban neighborhoods. The 2016 RTP/SCS scenarios attempted to address these challenges and balance the region's future mobility and housing needs with economic, environmental, and public health goals.

Section C in this chapter provides an overview of the land use and transportation strategies in the 2016 SCS, the expected outcomes of the plan as expressed by selected performance measures, and the region's implementation strategy. The land use and transportation strategies work together to encourage a development pattern that is more compact and offers more mobility choices, while also maintaining the transportation infrastructure and conserving open space. The 2016 RTP/SCS is anticipated to achieve per capita greenhouse gas emissions reduction of 8 percent in 2020 and 18 percent in 2035 relative to 2005.

A. Alternative Land Use and Transportation Scenarios

SCAG developed four scenarios to represent different land use and transportation strategies through 2040. Each scenario is based on the same assumptions about the total number of people, households, and employment in 2040. SCAG also used a new sketch planning tool, the Scenario Planning Model (SPM), to assist in scenario comparison and public outreach. This tool is based on the Urban Footprint model and is further described in Appendix A of this report.

SCAG conducted 23 public workshops and open houses to encourage public participation in the planning process.

Scenario 1 was considered the "business-as-usual" scenario and followed previous trends for growth and land use patterns. It included regionally significant highway and transit projects and transportation projects currently under, or approved for, construction. For new growth, 36 percent of homes would be located within a high-quality transit area (HQTA[17]) and 11 percent of new development would be in compact walkable communities.

Scenario 2 included new population, household, and employment trends identified through the bottom-up local input process. Land use patterns were based on local general plan land use policies and the transportation system included the 2012 RTP/SCS plus new projects proposed by the County Transportation Commissions. For new growth, 39 percent of homes would be located within HQTAs and 32 percent of new development would be in compact walkable communities.

Scenario 3 builds on Scenario 2 but increased growth in HQTAs and other compact, walkable areas with increased investments in transit integration and active transportation, including first/last mile improvements. It assumed most trips fewer than three miles would be replaced with walking and biking. This scenario also incorporated innovative technology such as bike share and car sharing. For new growth, 46 percent of homes would be located within HQTAs and 49 percent of new development would be in compact walkable communities.

Scenario 4 builds on Scenario 3 with even more growth focused in HQTAs and addresses climate resiliency. For example, no growth was assumed within potential sea

[17] HQTA are areas within one-half mile of a fixed guideway transit stop or a bus transit corridor where buses pick up passengers at a frequency of every 15 minutes or less during peak commuting hours.

level rise zones. This scenario was designed to achieve maximum per-capita greenhouse gas reductions. For new growth, 53 percent of homes would be located within HQTAs and 59 percent of new development would be in compact walkable communities.

These scenarios were developed in early 2015 and based on policy direction, public input, and analysis using the Regional Travel Demand Model (TDM) and SPM. The Preferred Scenario ultimately combined elements of all scenarios described above.

B. Preferred Scenario

The Preferred Scenario is more aggressive in achieving the sustainability goals than the 2012 RTP/SCS and reflects the following characteristics:

- HQTAs are expected to accommodate 46 percent of the total household growth and 55 percent of total employment growth[18]
- New housing development is anticipated to be 33 percent single-family and 67 percent multifamily
- Of new growth, 13 percent will be located in urban infill areas and 49 percent will be located in compact walkable areas
- It includes new mobility innovations such as bike sharing, carsharing, and ridesharing
- It redirects growth from high value habitat areas to existing urbanized areas to preserve natural lands
- It reduces spending on system expansion in favor of increased funding for roadway maintenance and rehabilitation compared to the 2012 RTP/SCS

Co-benefits associated with the Preferred Scenario include improved respiratory health due to active transportation opportunities, reduced infrastructure and service costs due to infill development, and reduced energy consumption and water conservation due to more compact development. The Preferred Scenario results in $3.3 billion saved in cumulative infrastructure costs to local governments, $600 million in avoided health costs, and creates almost 540,000 new jobs per year.

C. SCS Land Use Strategies

The land use strategies encourage a more compact urban form, with more mixed-use and infill development, and reuse of developed land that is also served by high quality

[18] Please note, no new growth or density increases are planned within the first 500 feet of an HQTA to reflect local input and guidance from the 2005 ARB Air Quality Manual

transit. The 2016 RTP/SCS anticipates half the expected growth will be accommodated on 3 percent of the total land.

Residential Density

The majority of new residential development is anticipated to be smaller lot homes or multi-family housing within existing communities. Only one third of new development will be single-family housing. As a result, the average housing density for the region is anticipated to increase from 2.8 dwelling units per residential acre to 3.5 dwelling units per residential acre between 2012 and 2040.

High Quality Transit Areas (HQTA)

About half the projected households and new jobs will be located within HQTAs, which represents about 3 percent of the total developable land. HQTAs are areas within one-half mile of a fixed guideway transit stop or a bus transit corridor where buses pick up passengers at a frequency of every 15 minutes or less during peak commuting hours. Focusing growth within HQTAs increases access to transit and avoids greenfield development which helps preserve natural lands. SCAG encourages local government to adopt policies that encourage growth in HQTAs including reduced parking requirements, adaptive reuse of existing structures, density bonuses, and increased investments for active transportation and complete streets. Total housing and employment within a half-mile of transit would increase 80 percent by 2040.

Livable Corridors

To encourage new growth in urban infill and walkable areas, SCAG developed a Livable Corridors concept that integrates transit improvements, active transportation improvements, and land use policies. Livable Corridors are located along major arterial and bus transit corridors and are not limited to HQTAs. This strategy aims to replace under-performing strip retail with higher density housing and employment centers at key nodes. SCAG provided technical assistance for 19 planning studies through the Sustainable Planning Grant program and identified 2,980 miles of Livable Corridors throughout the region. The County Transportation Commissions also helped identify key bus transit corridors for improved bus performance including BRT or semi-dedicated BRT-light, enhanced bus shelters, real-time travel information, and off-bus ticketing. The Livable Corridor components are not specific to any one particular corridor, but instead can be applied to corridors beyond those identified through the grant program. The Livable Corridor strategy encourages higher employment and housing densities, improved retail performance, and increased economic activity for local communities.

Land Conservation

The SCAG region has over 1.4 million acres of protected open space, regional parks, recreation facilities, and local parks. SCAG encourages the County Transportation Commissions to develop mitigation programs for future transportation measures to minimize the impacts on open space and protected lands. SCAG is also exploring funding opportunities for pilot programs to help implement the Open Space Conservation Plan once it is finalized. These pilots will help develop processes for land acquisition, restoration, and data collection. SCAG is also working with local jurisdictions and stakeholders to identify incentives to encourage cooperation across jurisdictional boundaries in order to protect and restore natural habitat corridors. Improvements to the transportation system will also increase public access to park and recreational areas.

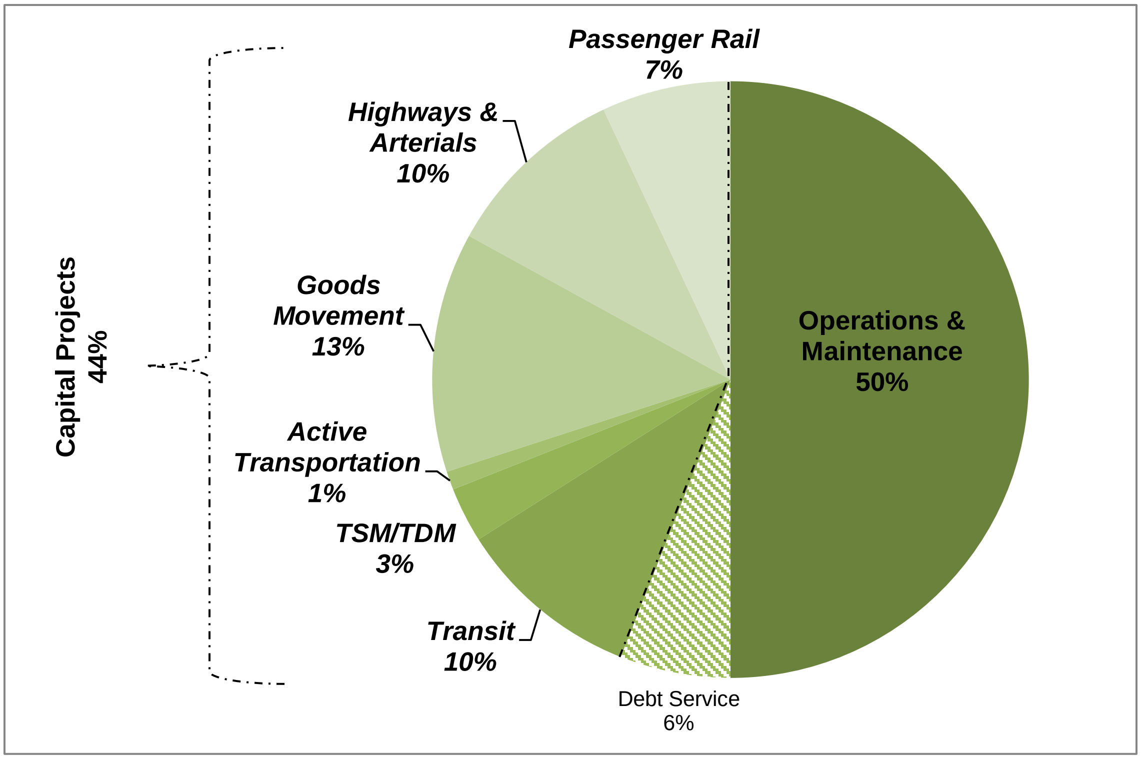
D. SCS Transportation Strategies

The transportation strategies complement and support the land use strategies. They focus on fixing and maintaining the current transportation infrastructure, while expanding non-automobile mobility options including transit and active transportation. This is reflected in the 2016 RTP/SCS budget which invests more in transit as well as operations and maintenance of the existing system than the previous plan. For the 2012 RTP/SCS, $226.03 billion was dedicated to operations and maintenance, which has increased to $275.5 billion for the 2016 RTP/SCS. For transit capital projects and operation and maintenance, the overall budget has increased from $256.6 billion to $267.1 billion[19].

Of the total RTP budget of $556.2 billion (in nominal dollars), 50 percent is dedicated to operations and maintenance, 44 percent is dedicated to capital projects, and the remainder is for debt service obligations. Almost 60 percent of the operations and maintenance budget is dedicated to transit. SCAG dedicated $8.1 billion dollars to bicycle and pedestrian improvements, an increase of over $1 billion from the last RTP/SCS. Figure 10 illustrates the 2016 funding allocation.

[19] All amounts are shown in 2016 dollars using the CPI Inflation Calculator found here: http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=246.2&year1=2012&year2=2016

Figure 10: SCAG 2016 RTP/SCS Budget 2016-2040



Source: SCAG 2016 RTP/SCS Transportation Finance Appendix, page 20

Almost half of the total RTP budget comes from local sources, including local sales tax measures in five of the six counties[20]. Ventura is the only county without a local sales tax measure dedicated to transportation, although it is seeking voter approval of a ballot measure in fall 2016. Additional local sources include toll fees, development impact fees, and transit farebox revenue. About one-third of the funding is anticipated from more innovative financing strategies such as a future mileage-based user fee, a gas excise tax adjustment to maintain historical purchasing power, private equity participation, freight fees, and investments from California High-Speed Rail (HSR). The remainder of the transportation funding is derived from federal and State sources.

Transit

The plan has a strong emphasis on transit operations and maintenance, including bus, BRT, rail, and paratransit operations; implementation of the transit plans such as OCTA's Short Range Transit Plan; expanded bus service on identified corridors; preventative maintenance; and expansion of Metrolink operations. Higher frequency

[20] The counties of Imperial, Orange, Riverside, and San Bernardino have a ½ cent sales tax and Los Angeles County has 1.5 cent sales tax, which is a combination of two permanent half-cent sales taxes and one non-permanent half-cent sales tax (Measure R).

service along a number of transit corridors and point-to-point express services are also planned.

The 2016 RTP/SCS investment for new transit projects is divided among rail facilities, transit vehicle replacement, bus system improvements, and rehabilitation/replacement projects. Examples include ten light rail projects and three heavy rail projects on the LA Metro rail system. Orange County will see two new streetcar lines to link major destinations with the Metrolink and Amtrak system. Metrolink expansions are planned for Riverside and San Bernardino County. Connections via rail are also expected for the Ontario, Burbank Bob Hope, and LAX airports. The Inland Empire, Los Angeles and Orange County will also have new BRT and rapid bus routes. By 2040, over 170,000 miles of bus routes and 72,000 miles of transit rail will be added to the system.

The SCAG region is also planning for California HSR, which is expected to reach the SCAG region in 2029. The California High-Speed Rail Authority is entering the environmental clearance phase for several of the segments located in the SCAG region. Stations are planned for Palmdale, Burbank Bob Hope Airport, Los Angeles Union Station, and Anaheim.

Roads

SCAG plans to focus on critical freeway gap-closures and expansion of managed lanes and the regional expressway network. These lanes give priority to buses, carpools, vanpools, and allow for express transit service. They also effectively manage congestion through pricing mechanisms. HOV, express lanes, and express lane connections are planned for more than ten routes throughout the region. By 2040, over 1,300 managed lane miles will be added to the transportation network compared to 683 general purpose freeway lane miles. The managed lanes will help create a seamless linked network throughout the region.

Active Transportation

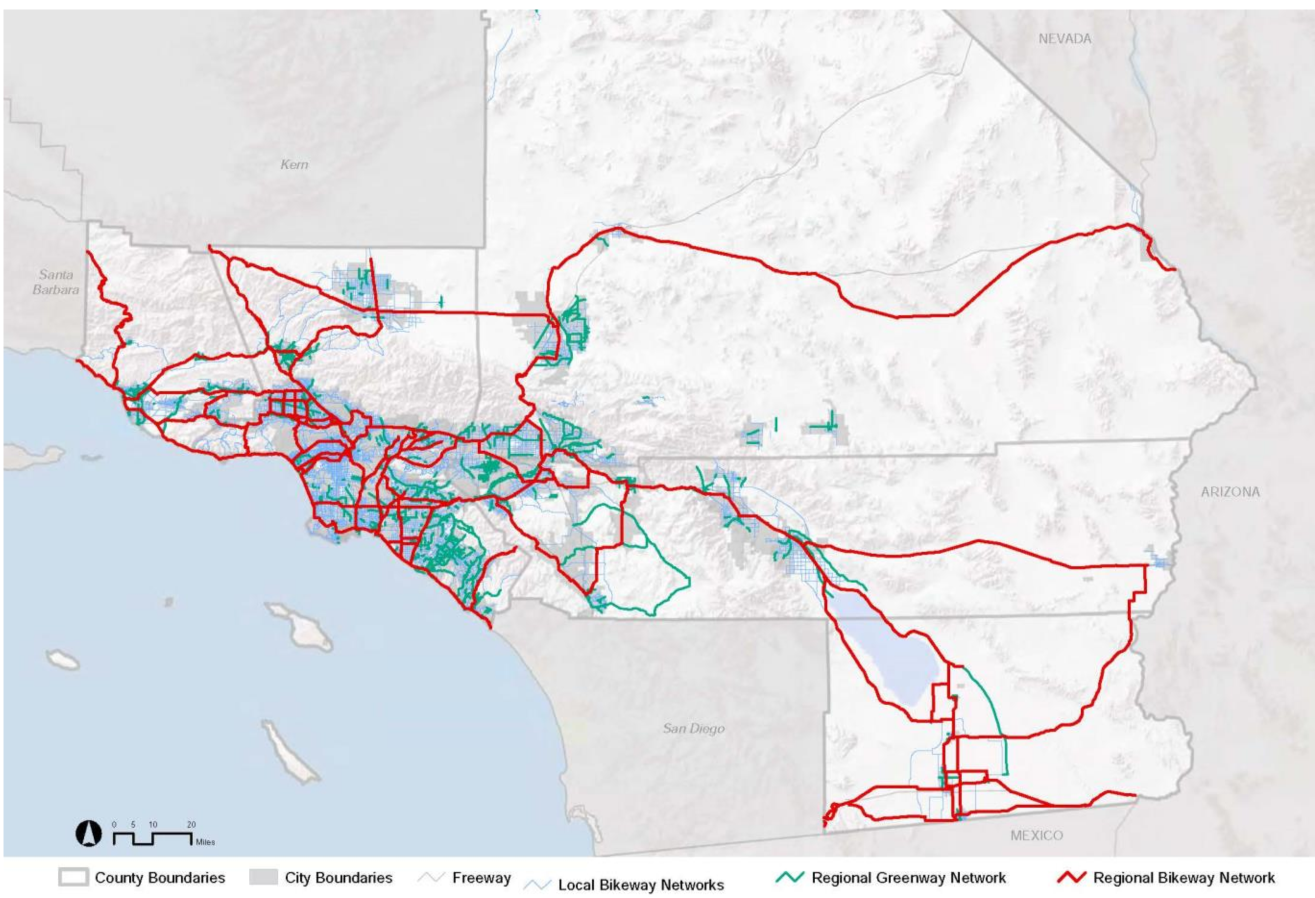
The 2016 RTP/SCS continues to build on the strategies and the regional bikeway network proposed in the 2012 RTP/SCS. SCAG's active transportation strategies are consistent with California's Complete Streets[21] program and are divided into four categories: regional trips, transit integration, short-trips, and education/encouragement. Transit integration includes bike share services, first/last mile connections, and Livable

[21] A complete street is a transportation facility that is planned, designed, operated, and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit vehicles, truckers, and motorists, appropriate to the function and context of the facility. http://www.dot.ca.gov/transplanning/ocp/complete-streets.html

Corridor improvements. Short-trip strategies include sidewalk improvements and a new concept, Neighborhood Mobility Areas.

SCAG also proposes to expand the regional greenway network. By 2040 this will be a 2,233-mile network comprised of separated bikeways (Class I and IV) that make use of available open space such as river trails, drainage canals, and utility corridors. The total bike network (Class I, II, III, and IV), comprised of the regional and greenway system, will increase from about 4,000 miles in 2012 to 12,700 miles in 2040 (Figure 11). In addition, first/last mile improvements are proposed for 224 fixed rail/guideway stations to provide opportunities for biking and walking and better integrate active transportation and transit. This includes new sidewalks, wayfinding signage, and additional bikeways. Lastly, bike share will also be expanded to include a total of 880 stations and 8,800 bikes.

Figure 11: Regional Bikeway Network (2040)



Source: SCAG 2016 RTP/SCS Active Transportation Appendix, Exhibit 12

Neighborhood Electric Vehicles (NEVs) and Regional Electric Charging Stations
SCAG developed the Neighborhood Mobility Area concept for the 2016 RTP/SCS, which intends to reduce the number of short trips made by gasoline powered vehicles in areas not served by high-quality transit. In the SCAG region, almost 40 percent of trips are less than three miles and the majority of these trips (78 percent) are made by driving. SCAG prepared GIS maps showing the highest ranking areas for walkability, pedestrian and bicyclist safety, and potential NEV use (i.e., speed limits under 35 mph) and removed areas served by high-quality transit. SCAG encourages the addition of bike lanes, wider sidewalks, and improved lighting to promote alternatives to driving especially in these areas. The strategy aims to replace 1.5 percent of all automobile trips under three miles with NEVs which will reduce greenhouse gas emissions and improve mobility.

SCAG proposes $274 million in regional charging station rebates focused on workplace and multi-family housing units to support the installation of 380,000 new EV charging stations. This will increase charging station access from 0.1 percent to 2.9 percent of households and employees within the urban and compact walkable areas by 2040[22]. SCAG intends to create more complete communities with a mix of land uses where most daily needs are met within a short distance of home. These strategies provide residents an opportunity to support local businesses, run daily errands by modes other than a single-occupant vehicle, and can lead to an improved quality of life.

Almost 40 percent of trips are less than three miles and the majority of these trips (78 percent) are made by driving.

[22] 2016 RTP/SCS Mobility Innovations Appendix, page 3

Transportation Demand Management/Transportation Systems Management
TDM strategies are focused on reducing peak period and SOV travel by encouraging behavior shifts to carpooling or vanpooling or reducing peak period travel. In addition to increasing the number of carpool lanes (discussed under Roads above), SCAG encourages employers to offer telecommuting or alternative work week schedules to help reduce peak period travel. Funds are dedicated to help jurisdictions develop TDM websites, TDM toolkits, park-and-ride lots, and commuter assistance programs. SCAG also encourages expansion of the Guaranteed Ride Home program for carpoolers and vanpoolers that need to return home due to an emergency. TDM strategies, together with emerging trends in the workplace, aim to increase telecommuting from 5 percent to 10 percent by 2040 and alternative work schedules from 4 percent to 15 percent by 2040.

TSM improvements include advanced ramp metering, enhanced incident management, expansion and integration of traffic signal synchronization, and data collection to monitor system performance. Corridor Mobility and Sustainability Improvement Plans have been completed for a number of corridors. These plans provide a framework for TSM strategies and explore ways to reduce congestion that are not limited to adding capacity. Technology improvements and ITS expansion are a subset of TSM strategies. ITS applications are not limited to arterial and highway systems but also apply to rail and transit systems, such as real time travel information and vehicle location identification. SCAG is already considering the implications of ITS and the future of automated and connected vehicles. TSM strategies help to better coordinate highways with transit and incorporate incident response management for a more efficient system.

V. 2016 SCS PLAN PERFORMANCE AND IMPLEMENTATION

Implementation of the projects and strategies in the 2016 RTP/SCS is expected to lead to changes across the region, as evidenced by several indicators. ARB staff analyzed eight indicators to determine whether they provide supportive, qualitative evidence that the SCS could meet its GHG targets. Staff relied on the relationships expressed in the empirical literature between each metric and VMT and/or GHG emissions to understand whether the changes are consistent with the SCS's forecasted GHG emission reduction trends. Data for this analysis came from the SCAG Data Table (Appendix B), which provided data for 2012, 2020, 2035, and 2040.

A. Land Use Indicators

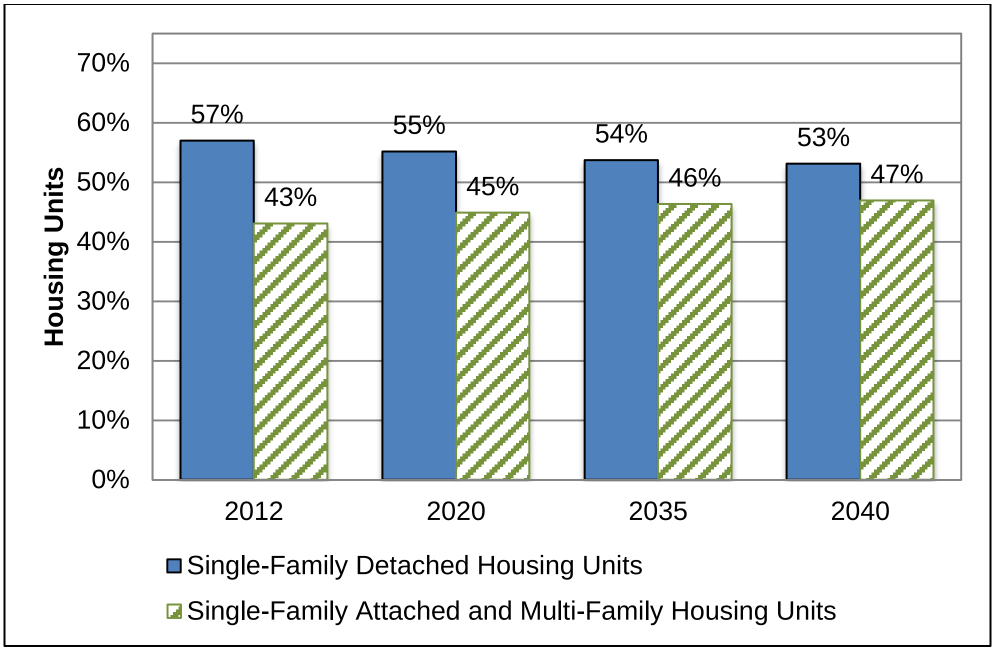
Land use influences the travel behavior of residents including both mode choice and trip length. The evaluation focused on three land use related performance indicators to determine whether they support SCAG's forecasted GHG emission forecast: change in mix of housing types, shift in residential lot size, and housing and employment in HQTA's.

1. Change in Mix of Housing Types

Travel characteristics in the region are expected to change as the housing stock shifts from single-family homes towards multi-family housing units. A greater proportion of single-family attached and multi-family development allows for higher densities that support lower VMT.

Between 2012 and 2040, SCAG shows an increase in single-family attached and multi-family housing units relative to the total number of housing units. Currently, single-family attached and multi-family housing units make up 43 percent of SCAG's total housing stock. Between 2012 and 2035, single-family attached and multi-family households are estimated to make up 62 percent of the new housing development. This will increase the regional proportion of single-family attached and multi-family housing units to 46 percent by 2035 (Figure 12). This trend further supports the forecasted GHG emissions reductions.

Figure 12: Share of Single-Family and Multi-Family Housing Units

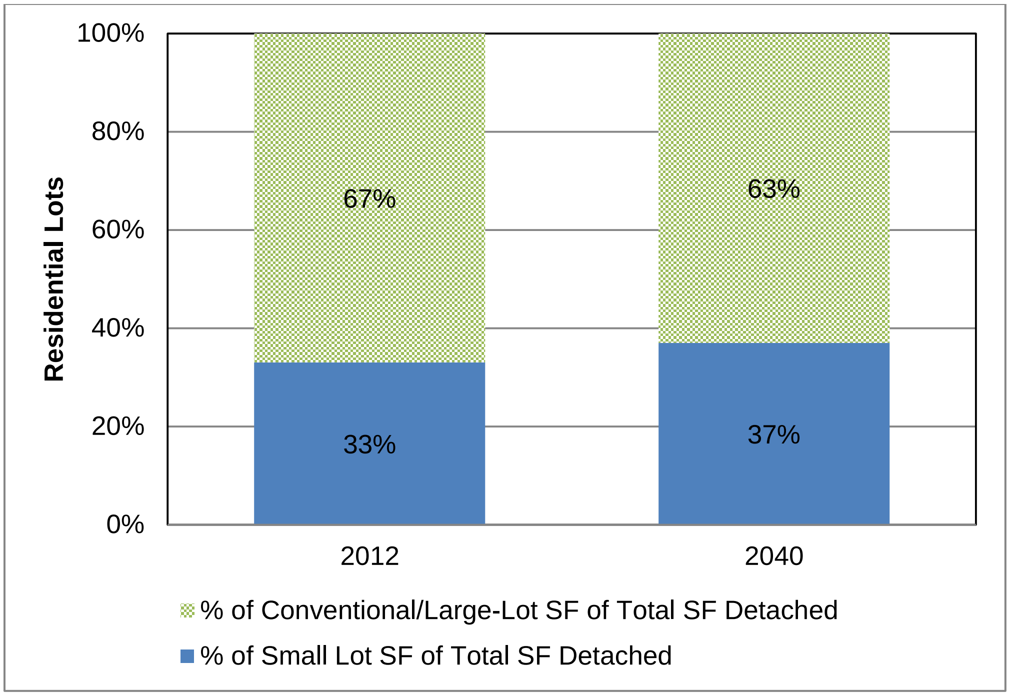


2. Shift in Residential Lot Size

A greater proportion of new housing units built between 2012 and 2035 are expected to be on smaller lots. Figure 13 shows that, of the total new single-family detached housing units in the region, the share of single-family homes on small-lots[23] is estimated to increase from 33 percent in 2012 to 37 percent by 2035. The greater the proportion of housing that is small-lot and attached housing types, the more opportunity a region has to accommodate future growth through a more compact land use pattern. As the housing stock shifts from single unit homes on large lots to single unit homes on smaller lots and multifamily housing, the travel characteristics in the SCAG region are expected to change.

[23] Small-lot size equals to or less than 5,500 square feet; large-lot size includes conventional-lots between 5,500 and 10,900 square feet and large-lots of 10,900 square feet or more.

Figure 13: Single-Family Lot Size

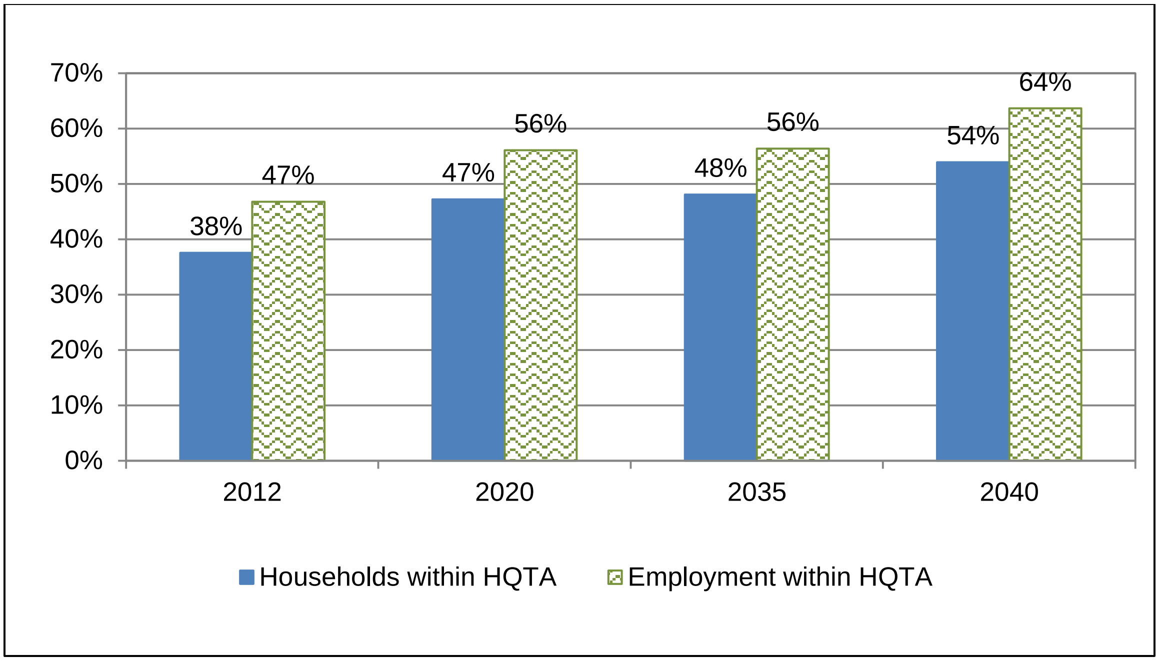


3. Housing and Employment in HQTAs

The SCS includes strategies to invest in transit near existing and future housing and employment locations. The empirical literature provides supporting evidence that concentrating housing and employment near transit stations can result in VMT and GHG emission reductions in the region. Tal, et al. (2010) suggests a 6 percent VMT decrease per mile closer to the rail station starting at 2.25 miles from the station and a 2 percent VMT decrease per 0.25 mile closer to a bus stop starting at 0.75 miles from the stop.

In the SCAG region, the projected percentage of all housing and employment within an HQTA is anticipated to increase between 2012 and 2040. Figure 14 shows that housing and employment within an HQTA would increase by about 10 percent between 2012 and 2035, supporting the forecasted GHG emissions reductions.

Figure 14: Housing and Employment in HQTAs



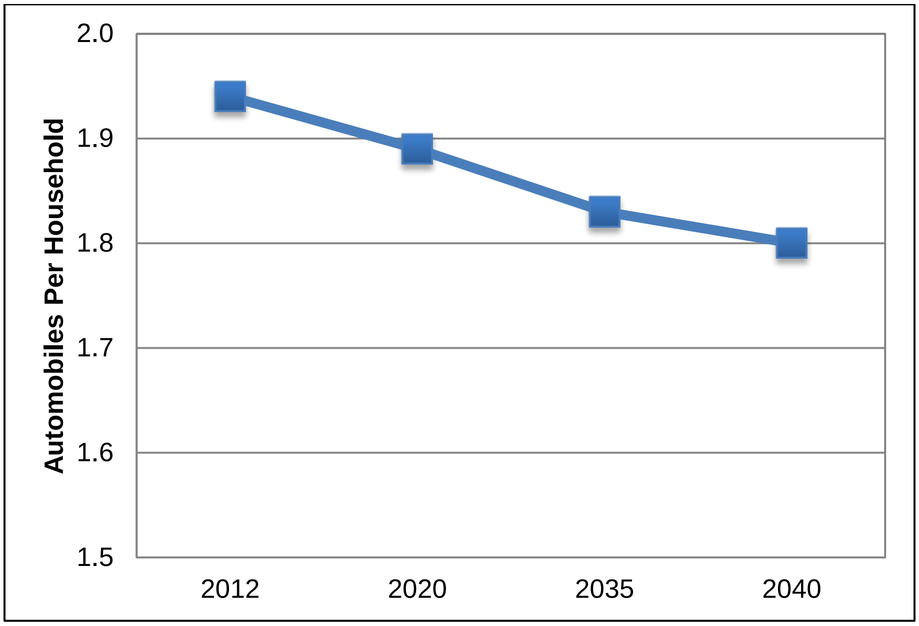
B. Transportation-Related Indicators

ARB staff evaluated five transportation-related performance indicators to determine whether the trends support the reported GHG emission reductions, including household auto ownership, mode share, managed lanes, reduced travel times, and per capital passenger VMT and CO_2 emissions. Each of these indicators is directionally consistent with and supportive of SCAG's determination that the SCS, if implemented, would achieve their GHG emission reduction targets.

1. Household Auto Ownership

The number of automobiles per household is closely tied to household VMT. Increasing housing and employment opportunities within existing communities and near transit stations may reduce a household's dependence on automobiles. This can lead to a reduction in the number and length of automobile trips and encourage mode shifts from driving to walking, biking, and transit. As a result, overall VMT is expected to decrease as auto ownership per household decreases. Research also shows that the availability of services such as car sharing, ridesourcing, dynamic on-demand private transit, and carpooling/vanpooling also correlates with a reduction in individual auto ownership. The 2016 RTP/SCS anticipates household auto ownership will decrease 10 percent from almost 2 vehicles per household in 2012 to 1.8 vehicles per household by 2040 (Figure 15).

Figure 15: Auto Ownership

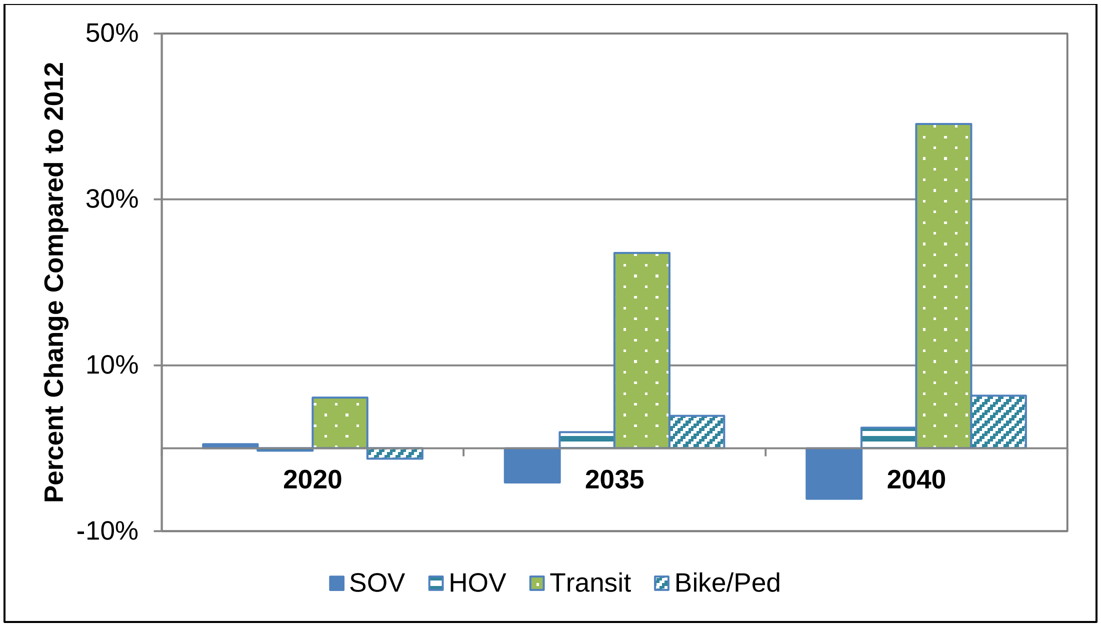


2. Mode Share

Shifting trips from vehicular to non-vehicular modes (e.g. bike, walk, working at home) can reduce regional GHG emissions. The empirical literature indicate that GHG emissions per person are likely to decrease as automobile mode share decreases and transit, bike, and walk mode shares increase.

Mode share for all trips measures how people travel from home-to-work and back, and how they travel for school, shopping, and all other non-work trip purposes. Figure 16 shows the expected mode share in 2020, 2035, and 2040 as compared to 2012. For 2020, there is a slight reduction in HOV and bike and pedestrian mode share and a slight increase in SOV mode share, but these projections can be explained by acceptable modeling error. By 2035, the trend shows the expected increase in HOV and bike and pedestrian modes. The drive alone mode share is projected to decrease over 4 percent, and the bike/walk mode share is expected to increase 4 percent by 2035. Small changes in mode shift for a region the size of SCAG can translate to notable reductions in regional emissions. Transit will experience the largest mode shift, increasing 24 percent between 2012 and 2035.

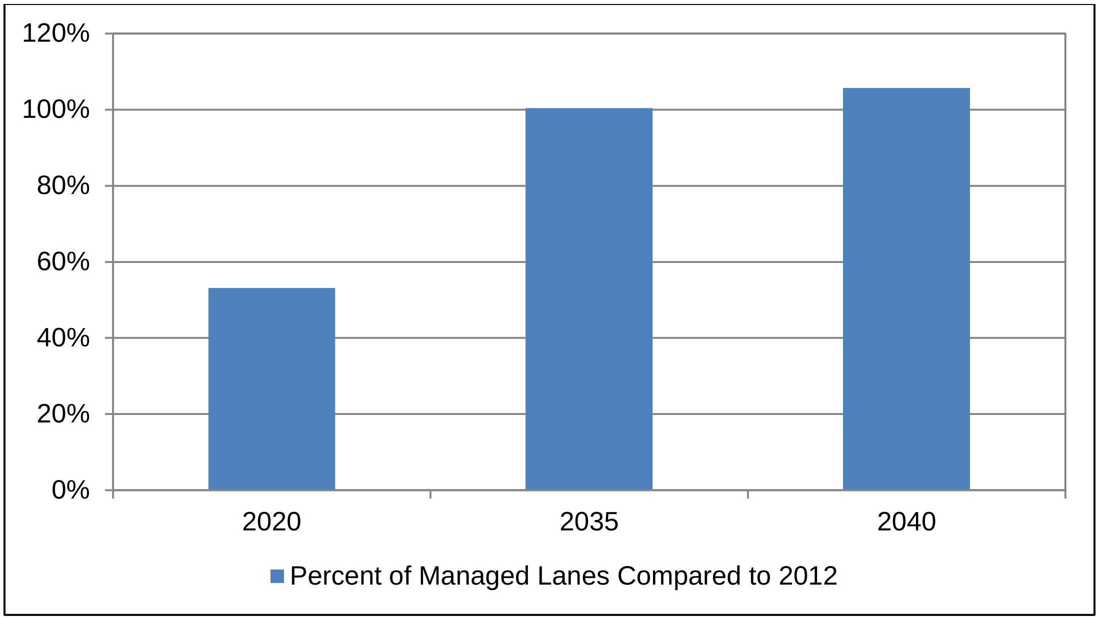
Figure 16: Mode Share Change



3. Managed Lanes

Managed lanes include HOV, HOT, and tolled lanes which give priority to buses, carpools, and vanpools, and better manage congestion through pricing mechanisms. Managed lanes have been shown to increase transit use and car occupancy especially in congested urban areas. This results in a reduction in vehicles trips and total VMT. Managed lane improvements are most effective when implemented as a regional network with linked lanes and supporting facilities and services. By 2040, the number of managed lanes will more than double over the base year from 1,256 to 2,583 lane miles and key gaps in the managed lane system will be closed (Figure 17).

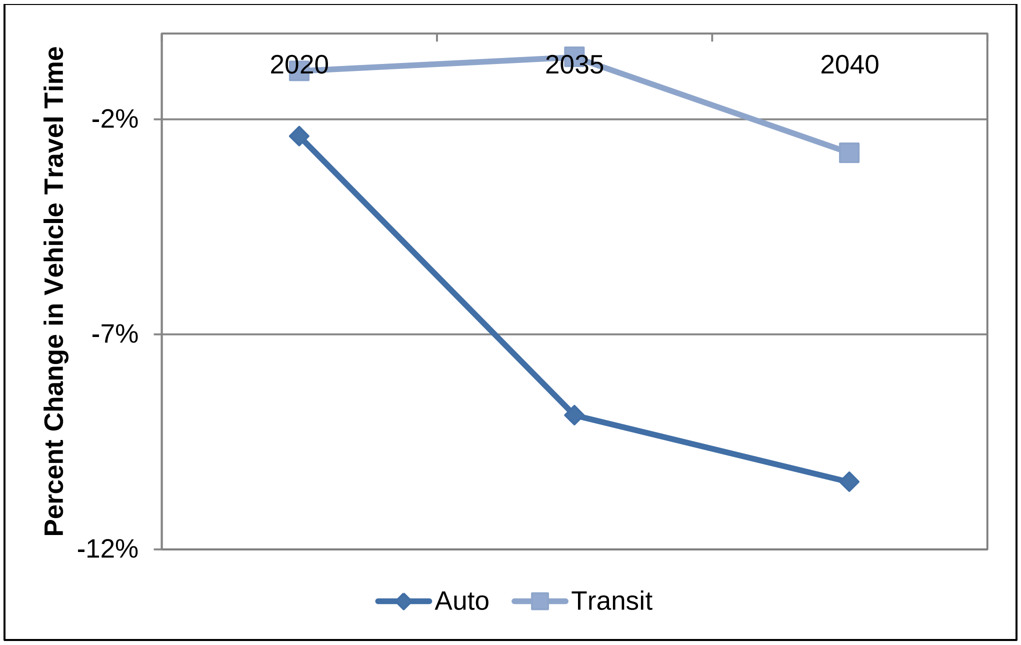
Figure 17: Managed Lanes Compared to 2012



4. Reduced Travel Times

A reduction in the total average travel time for transit is consistent with expectations of increased transit service area and ridership and mode choice decisions which might lead to GHG emission reductions. A reduction in travel time by automobile could also reduce fuel consumption and GHG emissions. In addition, a study by Barth and Boriboonsomsin (2008) in Southern California has estimated that speed management techniques could reduce 7 to 12 percent of CO_2 emissions. Figure 18 shows that by 2040, the total transit travel time decreases 3 percent and average automobile travel time decreases 10 percent compared to 2012. This figure also shows a slight increase in transit travel time between 2020 and 2035, which may result from a majority of transit projects reaching completion after 2035.

Figure 18: Travel Time Compared to 2012

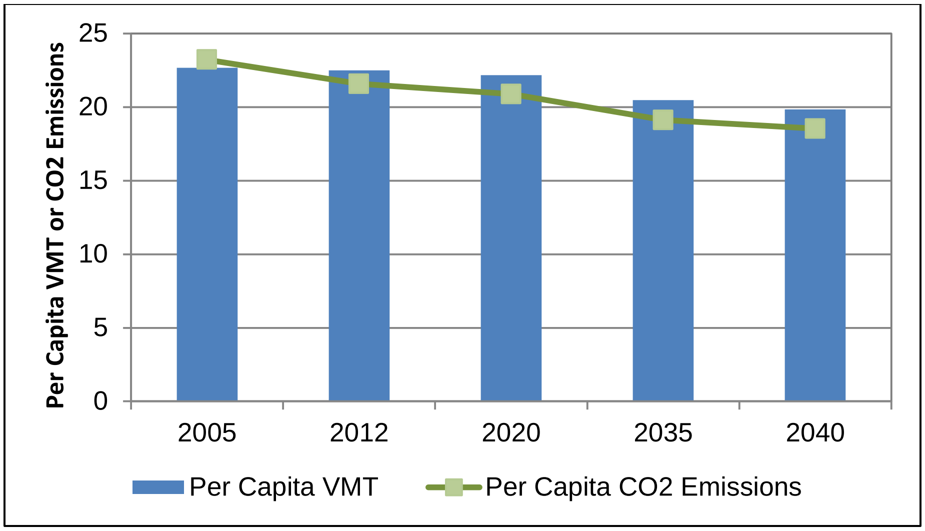


5. Per Capita Passenger Vehicle Miles Traveled and CO_2 Emissions

SCAG's VMT per capita trend closely follows the trend in CO_2 per capita emissions, showing a decline in both between 2012 and 2040. A decline in VMT per capita can result from a reduced amount of vehicle trips, mode shifting, or shorter trip distances due to a more compact urban form.

Decreases in average trip length for trips by auto can reduce a region's GHG emissions. Figure 19 illustrates the consistent downward trend of both per capita VMT and CO_2, each decreasing about 3 percent, between 2012 and 2035. Slight changes in per capita VMT and CO_2 can lead to large reductions at the regional level due to the size of the SCAG region.

Figure 19: Per Capita Passenger VMT and CO_2 Trends



C. 2016 SCS Implementation

The ability of the region to achieve the goals of the 2016 RTP/SCS will depend on successful implementation by both SCAG and local governments, in collaboration with transit operators, Caltrans, developers, and a wide range of interest groups. SCAG is also working to secure resources from federal and State agencies to implement the RTP/SCS, and is providing local governments with policy guidance, funding, and technical support.

State Funding Programs

Over $661 million has been awarded through the California Transportation Commission's Active Transportation Program and about $160 million from the Caltrans' Sustainable Transportation Planning Grant Program. Both programs will announce another round of funding summer of 2016. As of May 2015, SCAG has also been awarded over $333 million in Greenhouse Gas Reduction Funds through four programs (listed below). Another round of Greenhouse Gas Reduction Funding will be awarded late summer/fall 2016.

- *Affordable Housing and Sustainable Communities:* $42 million awarded for 12 projects in the SCAG region, four of which were for transit oriented development and the remaining were for integrated connectivity
- *Transit and Intercity Rail Capital Program:* Examples include $38.5 million awarded for LA Metro's Blue Line Operational Improvements, $2.3 million for OCTA rapid buses, $1.7 million for Pacific Surfliner Transfer Improvements, and $41.2 million for Metrolink corridor improvements in multiple counties
- *Low Carbon Transit Operations:* Examples include $5.9 million for LA Metro's Gold Line Foothill extension, $1.3 million awarded for an OCTA transit rider and

promotion program, $680,000 for Metrolink extension in San Bernardino County, $460,000 for new feeder bus service in Riverside County, and $215,000 to install bike racks on buses in Los Angeles

- *Low Carbon Transportation:* $1.7 million awarded for the Car Sharing and Mobility Options Pilot Project

In addition, in October 2015, LA Metro received $15 million from a U.S. Department of Transportation TIGER Grant to help repurpose a 6.4 mile section of abandoned railroad tracks as a Class I bicycle and pedestrian path in South Los Angeles, linking three transit lines—the Metro Blue Line LRT, Crenshaw/LAX Light Rail Transit, and the Silver Line BRT.

Technical Assistance
SCAG assists its local jurisdictions by providing a suite of planning tools to assist with SCS implementation. SCAG's website offers a centralized location for jurisdictions to obtain information on various tools and funding programs related to land use, transportation, and sustainability. It also assisted local jurisdictions to apply for grants through the Affordable Housing and Sustainable Communities funding program. The Go Human campaign will assist jurisdictions in obtaining Caltrans Active Transportation Grant funding. SCAG also conducts trainings to assist local jurisdictions on a variety of planning related topics.

REVISION (Regional Engaging, Visioning, & Implementing Sustainability through Infill Opportunities Network) is a web-based application for tracking a variety of metrics related to SCAG's SCS, including changes in the region's mobility and accessibility, housing, economics and employment, livability and health. A Map Tool within REVISION allows users to visually compare and contrast different neighborhoods within SCAG's six-county region. Users can track statistically significant change over time with REVISION's Trends Tool. REVISION also contains an Area Report, which provides a variety of statistics on over 10,000 census block groups in the region, and a Property Report, which presents data from County Assessors and other sources. Funding from the California Strategic Growth Council helped SCAG and the UCLA Lewis Center create REVISION.

SCAG provides free classes to local government planners through its "Toolbox Tuesdays" program. Classes focus on practical skills such as the use of computer-based tools, including REVISION, and education on practical approaches relevant to planning issues. Recent Toolbox Tuesday topics include Caltrans' 2016/17 Active Transportation Program; policy issues regarding autonomous vehicles, the City of Santa Monica's Transportation Demand Management Ordinance; and an overview of complete streets legislation.

VI. CONCLUSION

SCAG used several models to quantify GHG emissions that would result from implementation of the 2016 RTP/SCS including the region's travel demand model, off-model quantification tools, and EMFAC 2014. Refinements to the travel demand model since 2012 include new model validation tests, new model sensitivity tests, and some new data inputs and assumptions. The Scenario Planning Model (SPM) was used for the first time for the 2016 RTP/SCS to analyze the benefits of active transportation investments and land use scenarios. In addition, SCAG used off-model quantification tools for SCS strategies to which the model was not sensitive. A description of ARB staff's technical review of SCAG's 2016 RTP/SCS is found in Appendix A of this report.

Based on all the evidence, including the region's travel model documentation, model validation report, modeling assumptions, model inputs and outputs, the SCS strategies, and the performance indicators, ARB staff concludes that SCAG's 2016 RTP/SCS would, if implemented, meet the Board adopted per capita GHG emissions reduction targets of 8 percent reduction in 2020 and 13 percent reduction in 2035 from a base year of 2005.

VII. REFERENCES

American Public Transportation Association. 2015. Public Transportation Fact Book, 66th Edition. November 2015. http://www.apta.com/resources/statistics/Documents/FactBook/2015-APTA-Fact-Book.pdf

Amtrak. 2016. About Amtrak California. http://amtrakcalifornia.com/about/. Accessed June 8, 2016.

Barth, Matthew, and Kanok Boriboonsomsin. “Real-World CO2 Impacts of Traffic Congestion.” Transportation Research Record: Journal of the Transportation Research Board, 2058 (2008): 163-171.

California Air Resources Board. 2011. Description of Methodology for ARB Staff Reivew of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375. July 2011. http://www.arb.ca.gov/cc/sb375/scs_review_methodology.pdf

California Air Resources Board. 2016. Mobile Source Emissions Inventory – Categories. February 2016. http://www.arb.ca.gov/msei/categories.htm#emfac2014

California Department of Finance, Report P-1 (County): State and County Total Population Projections, 2010-2060. Sacramento, California, 2014. http://www.dof.ca.gov/research/demographic/reports/projections/P-1/

California Department of Transportation. 2015. Fiscal Year 2015-2016 Caltrans Sustainable Transportation Planning Grant Awards. http://www.dot.ca.gov/hq/tpp/documents/AwardList.pdf

California Department of Transportation. 2015. Cycle 2 Active Transportation Program. http://www.dot.ca.gov/hq/LocalPrograms/atp/cycle-2.html

California Department of Transportation. 2015. Transit and Intercity Rail Capital Program (TIRCP) Project Awardee Summaries. http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/TIRCPAwardSummary06302015.pdf

California Transportation Commission. 2010. Regional Transportation Plan Guidelines. http://www.catc.ca.gov/programs/rtp/2010_RTP_Guidelines.pdf

Federal Highway Administration United States Department of Transportation. 2015. Managed Lanes: A Primer. Accessed June 8, 2016. http://ops.fhwa.dot.gov/publications/managelanes_primer/

Los Angeles County Metropolitan Transportation Authority. 2016. Ridership Statistics: Interactive Ridership Stats – Line Level Trends and Historical Info. http://isotp.metro.net/MetroRidership/Index.aspx. Accessed June 8, 2016.

Metrolink. 2015. Our Future is on Track: Metrolink Short-Range Transit Plan 2015-2020. http://www.metrolinktrains.com/agency/page/title/Metrolink_Strategic_Plan

Metrolink. 2015. Our Future is on Track: Metrolink 10-Year Strategic Plan 2015-2025. http://www.metrolinktrains.com/agency/page/title/Metrolink_Strategic_Plan

Metrolink. 2016. The Agency: Facts & Numbers. http://www.metrolinktrains.com/agency/page/title/facts. Accessed June 8, 2016.

Metrolink. 2016. Metrolink Extension of the 91 Line. http://perrisvalleyline.info/. Accessed June 8, 2016.

Southern California Association of Governments. 2012. Final Regional Transportation Plan 2012-2035: Sustainable Communities Strategy Towards a Sustainable Future. April 2012.

Southern California Association of Governments. 2012. Southern California Plug-in Electric Vehicle Readiness Plan. December 2012.

Southern California Association of Governments. 2013. South Bay Cities Plug-in Electric Vehicle Deployment Plan. June 2013. http://164.67.121.27/files/Downloads/luskincenter/ev/SBCOG_plan.pdf

Southern California Association of Governments. 2013. California Bicycle Route 66 Concept Plan. August 15, 2013.

Southern California Association of Governments. 2015. Draft Programmatic Environmental Impact Report for the 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy. November 2015.

Southern California Association of Governments. 2015. Draft SCAG Regional Travel Demand Model and 2012 Model Validation, December 2015. http://www.scag.ca.gov/Documents/SCAG_RTDM_2012ModelValidation.pdf

Southern California Association of Governments. 2015. Draft 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy: A Plan for Mobility, Accessibility, Sustainability and a High Quality of Life. December 2015.

Southern California Association of Governments. 2015. Local Profile County and Regional Data. Sent to ARB December 16, 2015.

Southern California Association of Governments. 2016. Final Programmatic Environmental Impact Report for the 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy. April 2016.

Southern California Association of Governments. 2016. SPM Active Transportation Analysis Tool presentation, January 2016.

Southern California Association of Governments. 2016. The 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy: A Plan for Mobility, Accessibility, Sustainability and a High Quality of Life, April 2016. http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS.pdf

Transportation Research Board. 2012. Travel Estimation Techniques for Urban Planning. National Cooperative Highway Research Program (NCHRP) Report 716. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_716.pdf

U.S. Census Bureau. 2014. American Community Survey 2006-2014. https://www.census.gov/programs-surveys/acs/

APPENDIX A. ARB TECHNICAL REVIEW

ARB staff's technical review of SCAG's 2016 RTP/SCS focused on the aspects of regional modeling that underlie the quantification of GHG emissions reductions. All technical data and analysis presented in this appendix reflect the information available to ARB staff during its review of SCAG's 2016 SCS, including the supporting data provided by SCAG as shown in Appendix B. The general method of review is outlined in ARB's July 2011 document entitled "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies Pursuant to SB 375." ARB's general methodology is tailored to address each region's unique characteristics.

SCAG used the same modeling system for both its 2012 RTP/SCS and its 2016 RTP/SCS. Therefore, this technical review does not repeat ARB's prior evaluation of SCAG's model, but only discusses changes that have taken place since 2012. Those changes include new model validation tests, new model sensitivity tests, off-model adjustments for new SCS strategies, and some new data inputs and assumptions. For more information on SCAG's model and modeling system, refer to ARB staff's May 2012 technical evaluation of SCAG's 2012 RTP/SCS at http://www.arb.ca.gov/cc/sb375/scag_scs_tech_eval0512.pdf.

ARB staff's evaluation of SCAG's SCS and its technical documentation indicates that if implemented, the SCS would meet or exceed the GHG emissions reduction targets set by the Board.

I. Data Inputs and Assumptions for Modeling Tools

SCAG's key model inputs and assumptions were evaluated to confirm that model inputs represent current and reliable data, and were used appropriately. Specifically, a subset of the most relevant model inputs were reviewed, including: 1) regional socioeconomic characteristics and growth assumptions, 2) the region's transportation network inputs and assumptions, and 3) cost assumptions. In evaluating these three input types, ARB staff reviewed the assumptions SCAG used to forecast growth and vehicle miles traveled (VMT), and compared model inputs with underlying data sources. This involved using publicly available, authoritative sources of information, such as national and statewide survey data on socioeconomic and travel factors, as well as region-specific forecasting documentation.

A. Regional Socioeconomic Forecast

SCAG's regional growth forecast includes three major indicators: population, households, and employment. SCAG developed the regional growth forecast and socioeconomic assumptions based on input from an expert panel in 2013, development of a range of regional growth forecasts, and incorporation of local input.
The regional growth forecast for the 2016 RTP/SCS was developed using the same methodology used in the 2012 regional growth forecast. SCAG projects regional employment using a shift-share model, which computes employment comprised of twenty broad North American Industry Classification System (NAICS) sectors using a regional share of the nation's employment. The shift-share model estimates employment for both the number of total jobs in the U.S. and the distribution of these jobs among industry sectors. SCAG assumed the region's share of the national jobs in 2040 to remain at the 5.3 percent observed in 2015. The regional population forecast was estimated using the cohort-component model, which estimates future population by adding the number of group quarters population, births, and persons moving into the region during a projection period to the existing population, and then subtracting the number of persons moving out of the region. Households are forecasted by multiplying the projected residential population by projected headship rates, which is a proportion of a population cohort that forms the household. Table 1 summarizes the base and forecasted year demographics in the region.

Table 1: Summary of Growth Forecast (thousands)

Year	Population	Households	Employment
2012	18,318	5,883	7,436
2020	19,390	6,413	8,503
2035	21,481	7,170	9,568
2040	22,132	7,410	9,868

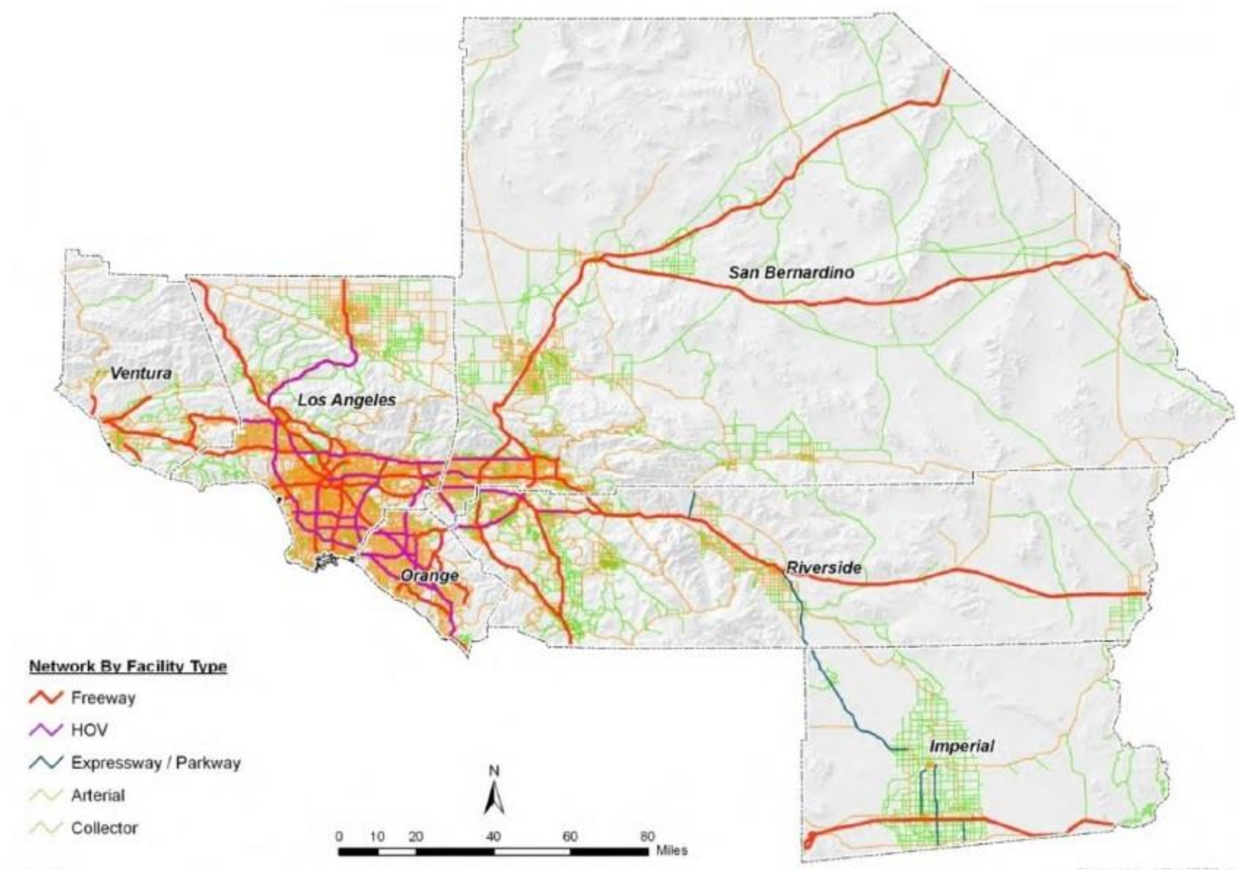
Source: SCAG Data Table (see Appendix B)

After demographic data were estimated at the regional level, SCAG processed the socioeconomic data at the Transportation Analysis Zone (TAZ) level as input data to the travel demand model. A total of sixty-five socioeconomic variables and eight joint tables were developed as input for the travel demand model. For example, population, household by types, household income by categories, and employment by sectors. Major data sources SCAG used in projecting TAZ level demographic data include the 2000 and 2010 Census, the American Community Survey (ACS), the California Department of Finance (DOF), the California Employment Development Department (EDD), firm based InfoGroup data, the 2012 Existing Land Use, and County Assessor's Parcel Database.

B. Transportation Network Inputs and Assumptions

The transportation network is a map-based representation of the transportation system serving the SCAG region. One part of the transportation network is the highway network (Figure 1), which is an inventory of the existing roadway system. The highway network is used to estimate the highway travel times and distances, simulate automobile travel, and estimate associated impacts such as pollution, energy consumption, and accidents. The base year highway network lane miles by facility type is summarized in Table 2. SCAG conducted a detailed review and update of the highway network using aerial photography to ensure the base year network accurately represented 2012 conditions.

Figure 1: Regional Highway Network (2012)



Source: SCAG (2015). Draft SCAG Regional Travel Demand Model and 2012 Model Validation

Table 2: SCAG Highway Network Lane Miles by Facility Type (2012)

Facility Type	Lane Miles
Freeway general purpose lanes	11,048
Freeway managed lanes	1,256
Major Arterial / Expressway	16,252
Minor Arterial	19,946
Collectors	16,717
Locals	5,649

The second part of the transportation network is the transit network, which is used to model the impacts of transit and land use strategies on travel patterns throughout the region (Table 3). The base year transit network includes 3,000 transit route patterns for more than seventy transit carriers in the SCAG region. Transit service in the SCAG region is grouped into seven transit modes (commuter rail, local rail, express bus, rapid bus, local bus, transitway bus, bus rapid transit (BRT) and four non-transit modes based on service characteristics and fare structures. High speed rail has been added as a transit mode in the future year transit networks.

Table 3: SCAG Transit Network Lane Miles by Facility Type (2012)

Transit Facility Type	Lane Miles
Regular transit bus operation miles	494,422
Bus rapid transit bus operation miles	6,036
Express bus operation miles	66,501
Transit rail operation miles	33,836

C. Travel Demand Model Inputs and Assumptions

The number of trips associated with various land uses, and the time and length of those trips based on trip destinations can influence the amount of travel within a study region. Key model inputs for each step of the travel model (e.g. number of trips produced per household by purpose) were reviewed and compared to those from independent data sources using the methods described in the 2011 “Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375.” This review allowed ARB staff to understand the variables used in the model, variable assumptions, and the model input data sources.

1. Trip Generation Rates

Trip generation is the average of the daily person trips for each trip type in a planning region. SCAG used the regional travel demand model to estimate production trips and attraction trips based on the 2012 California Household Travel Survey (2012 CHTS) and the SCAG household travel survey data.

Table 4 summarizes modeled trip rates by trip purpose. Compared to the trip rates reported in the National Cooperative Highway Research Program (NCHRP) report 716, the SCAG region has relatively more commute trips and less of the other trips.

Table 4: Trip Generation Rates by Trip Purpose

Trip Purpose	Average Daily Person Trips Per Household		Percent Difference
	SCAG's Model	NCHRP Report 716	
Home-Based Work	1.9	1.4	36%
Home-Based Other	4.7	4.9	-3%
Non-Home-Based	2.5	3	-17%
Total	9.1	8.5	7%

2. Trip Time and Distance Distribution

In the trip distribution step of travel modeling for the SCAG region, trip time and distance estimated using the highway network, are used as inputs to quantify travel impedances between zones. The SCAG trip distribution modeling step uses a gravity model for school trips and a destination choice model for the other trip purposes. These models were calibrated using the 2012 CHTS. Table 5 shows the modeled travel time by mode. Compared to national average, travel time by auto in the SCAG region is less than the national level, but traveling via non-motorized and transit modes are longer than the national average. As a major metropolitan area, bike and pedestrian facility and transit service are more developed and continuous for users than an average city in the nation. Table 6 shows the trip length by mode.

Table 5: Average Travel Time by Mode

Mode	Average Travel Time (minutes)	
	2012 SCAG Model	2009 NHTS
Auto	16.83	19
Non-motorized	25.77	15
Transit	71.36	48

Table 6: Average Trip Distance by Mode

Mode	Average Trip Distance (miles)	
	2012 SCAG Model	2009 NHTS
Auto	11.04	12.09
Walk	1.29	0.98
Bike	4.21	N/A
Transit	11.69	10.18

D. Cost Inputs and Assumptions

Travel cost is one of the major factors determining the mode of transportation for a trip. ARB staff reviewed several basic travel cost components used as inputs in the SCAG travel model: auto operating cost (which includes fuel cost and non-fuel based cost) and mileage-based user fee (also known as VMT fee). Staff also evaluated sensitivity tests, such as those for gasoline price, transit frequency, and transit fare, to examine how responsive the SCAG model is to VMT associated with the 2012 RTP/SCS. Additional sensitivity tests are presented in the model sensitivity analysis section of this appendix.

1. Auto Operating Cost

Auto operating cost, comprised of fuel price and tire and maintenance cost, is a key parameter used in the mode choice step of the SCAG model. Similar to the collaborative effort among the “big four” MPOs to arrive at consistent auto operating cost assumptions for their first SCSs, SCAG worked with MTC, SANDAG, and SACOG to use an updated and consistent methodology to estimate auto operating cost[24] for the second round of SCSs. The MPOs agreed to define auto operating cost as a combination of historical information from 2005 and region-specific forecasted fuel price based on the 2013 U.S. Department of Energy’s annual forecast of motor vehicle gasoline prices. In addition, the MPOs added 32 cents per gallon to account for gasoline being more expensive in California than the rest of the nation. Table 7 summarizes the auto operating costs estimated by SCAG for 2020 and 2035. ARB staff reviewed SCAG’s methodology to estimate base and future year auto operating cost, and found it to be consistent with the other “big four” MPOs.

[24] Automobile Operating Cost for the Second Round of Sustainable Communities Strategies; MOU by MTC, SCAG, SACOG and SANDAG. October, 2014.

Table 7: SCAG Region Auto Operating Cost (in Year 2010 dollars)

Year	Fuel Price ($/gallon)	Tire & Maintenance (cents/mile)	Fuel Economy[25] (miles/gallon)	Auto Operating Cost (cents/mile)
2005	2.85	5	18.63	20.3
2020	4.12	7	23.63	24.3
2035	4.89	9	26.4	27.3

2. Mileage-Based User Fee

Besides auto operating cost, the 2016 RTP/SCS assumes that roadway users in the SCAG region will also be affected by the introduction of a mileage-based user fee (also known as a VMT fee). The VMT fee would generate revenue for transportation financing purpose. The VMT fee is estimated at about $0.04 (in 2015 dollars) per mile starting in year 2025. SCAG also performed a sensitivity test to study the impact of a VMT fee on travel in the region. Results of the model’s responsiveness to the application and variation of VMT fee are discussed in the sensitivity analysis section of this appendix.

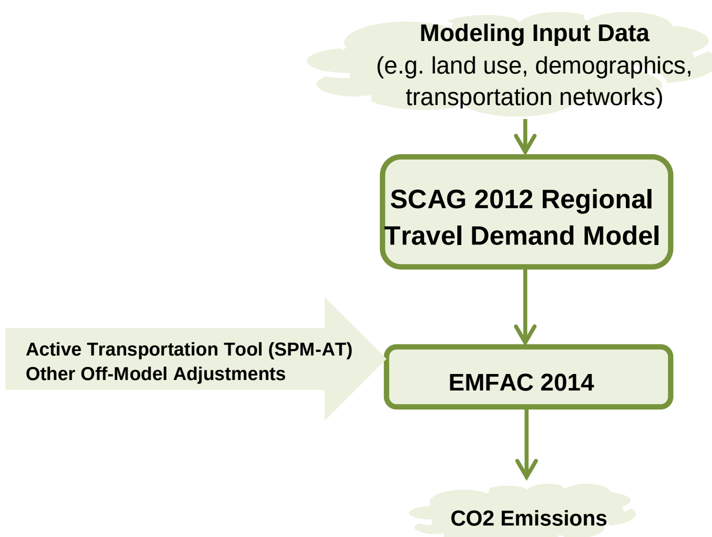
.

[25] Region specific effective passenger vehicle fuel efficiency from EMFAC.

II. Overview of Modeling Tools

SCAG used several models to quantify GHG emissions that would result from implementation of the 2016 RTP/SCS (Figure 2). SCAG's travel demand model estimated base and forecasted year travel demand based on a number of different modeling inputs, such as base year population, employment, and planning assumptions about future year land use, housing, and the transportation network. SCAG also estimated additional GHG emissions reductions from innovative strategies to which the travel model is not responsive. Using the VMT outputs from its travel model, SCAG then estimated the reduction in GHG emissions from implementation of its SCS for 2020 and 2035 by running ARB's vehicle emissions model, EMFAC 2014. The section below describes the various models used to develop the 2016 RTP/SCS in greater detail as well as planned model improvements that SCAG is developing for its next RTP update in 2020.

Figure 2: SCAG's Modeling Tools



A. Travel Demand Model

SCAG used the same trip-based travel demand model that it used for the 2012 RTP/SCS, and updated the model calibration based on the 2012 CHTS which was not available at the time the 2012 RTP/SCS was developed. Major model input data sources include the 2000 and 2010 Census, the American Community Survey (ACS), the California Department of Finance (DOF), the California Employment Development Department (EDD), empirical studies, and the 2012 Land Use and County Assessor's Parcel Database. For details about SCAG's travel model and ARB's review of the model, please see ARB's 2012 *Technical Evaluation of the Greenhouse Gas Emission*

Reduction Quantification for the Southern California Association of Governments' SB 375 Sustainable Communities Strategy (pg. 17 to 29) at http://www.arb.ca.gov/cc/sb375/scag_scs_tech_eval0512.pdf.

1. Model Improvements Since 2012

The updated model reflects recommendations of the peer review panel made during the last model update which occurred during the development of the 2012 RTP/SCS. SCAG recalibrated the entire model using the 2012 CHTS, 2012 SCAG travel survey, and the 2012 transit on-board survey and ridership data. Other model improvements include the updated vehicle ownership model and mode choice model, re-estimation of trip production rates, updates to the transportation networks, and enhancement of sensitivity to pricing and transit-oriented development strategies.

Scenario Planning Model-Active Transportation Tool
SCAG developed a Scenario Planning Model - Active Transportation (SPM-AT) tool to analyze the impact of enhanced active transportation infrastructure. Using the SPM-AT tool enables the mode choice model to reallocate trips among the different modes, and capture more walk and bikes trips that would result from the active transportation investments in the 2016 RTP/SCS. SCAG estimated VMT reduction from increased substitution of non-motorized trips for vehicle trips by using the average vehicle occupancy (1.5 persons per vehicle), and the assumed average trip length for walk, bike, and transit based on the 2012 CHTS data. Table 8 summarizes the number of trips by mode with the application of the SPM-AT tool for Year 2040.

Table 8: Mode Choice Outputs of the 2040 Planning Scenario Using the SPM-AT Tool (person trips)

Mode	Travel Model and SPM-AT Tool	Travel Model Only	Percent Difference
Walk	8,260,390	10,008,035	21%
Bike	1,048,159	1,622,969	55%
Transit	2,107,617	2,301,980	9%
Auto	62,434,246	59,917,428	-4%
Total	**73,850,412**	**73,850,412**	**0%**

2. Model Validation

Modeled output for the plan's base year of 2012 was validated by using regional traffic counts, regional transit boarding counts, VMT from the Highway Performance

Monitoring System (HPMS), speed data from the Freeway Performance Measurement System (PeMS), and other travel survey data.

Trip Production

Table 9 summarizes the validation results of trip production estimation. The differences between the 2012 model estimate and observed data were under five percent.

Table 9: Trip Production Validation

Trip Purpose[26]	Model Estimate	2012 CHTS	Percent Difference
HBWD	8,960,693	9,220,900	-2.8%
HBWS	1,884,606	1,939,400	-2.8%
HBSC	4,718,142	4,581,800	3.0%
HBCU	699,938	672,600	4.1%
HBSH	4,897,836	4,803,000	2.0%
HBSR	7,409,153	7,380,500	0.4%
HBO	10,575,864	10,456,900	1.1%
HBSP	6,433,085	6,541,400	-1.7%
OBO	14,579,200	14,565,800	0.1%
WBO	3,372,527	3,221,700	4.7%
Total	**63,531,044**	**63,384,000**	**0.2%**

Source: SCAG (2015). Draft SCAG Regional Travel Demand Model and 2012 Model Validation

Trip Distribution

In the trip distribution step of the modeling process, average trip length results were validated by trip purpose, time period and household segment type. Most of the modeled to observed trip length ratios were within ten percent difference except for a few trip purposes and time periods combined. Data sources for validation include 2012 CHTS, 2012 SCAG household travel survey, and ACS 2012 5-Year Release worker flow matrix.

Traffic Assignment

[26] These are the trip purposes defined in the 2012 SCAG travel model: Home-Based Work Direct (HBWD), Home-Based Work Strategic (HBWS), Home-Based School (HBSC), Home-Based College (HBCU), Home-Based Shopping (HBSH), Home-Based Social-Recreational (HBSR), Home-Based Other (HBO), Home-Based Serving-Passenger (HBSP), Other-Based Other (OBO), and Work-Based Other (WBO) trips.

For traffic assignment validation, SCAG performed screenline analyses and compared results to observed data from HPMS. Table 10 summarizes the modeled total VMT for all vehicles combined compared to observed data, showing a difference of only two percent.

Table 10: Highway Assignment Validation

	Modeled	HPMS	Percent Difference
Total VMT (000s)	440,289	447,594	-2%

Table 11 summarizes the modeled daily transit boardings in 2012 compared to observed transit data.

Table 11: Year 2012 Transit Boarding Validation

Transit Mode	Model Estimate	Reported Boardings	Percent Difference
Commuter Rail	46,077	44,472	3.6%
Urban Rail	373,547	356,648	4.7%
MTA Bus[27]	1,241,911	1,190,314	4.3%
Other Transit[28]	947,390	763,648	24.1%
Total	**2,608,925**	**2,355,082**	**10.8%**

Source: SCAG (2015). Draft SCAG Regional Travel Demand Model and 2012 Model Validation

Overall, SCAG's travel demand model was developed in accordance with the CTC's 2010 RTP and FHWA guidelines. The CTC's "2010 California RTP Guidelines," provide both requirements and recommendations for large MPOs, like SCAG, to enhance the modeling capabilities and validation procedures, as listed in Appendix C.

B. Off-Model Adjustments

Similar to other California MPOs, SCAG calculated off-model adjustments to estimate GHG emissions reductions from strategies to which the travel model is not sensitive. These off-model adjustments are based on existing methodologies used by other MPO(s), local knowledge and data collection, and existing studies which demonstrate the potential for GHG emissions reductions from new strategies in the 2016 RTP/SCS,

[27] MTA Bus includes local bus, rapid bus, express bus operated by LACMTA.
[28] Other transit includes local bus, rapid bus, express bus operated by other transit providers in SCAG region.

including Zero Emission Vehicles, Neighborhood Electric Vehicles (NEVs) and shared mobility services (for example, car sharing and ridesourcing).

Active Transportation Enhancement

SCAG analyzed the potential impact of active transportation infrastructure enhancement on mode share and VMT by using the 2012 travel demand model and the SPM-AT tool. After estimating mode share using the travel demand model, variables such as socioeconomic characteristics from the 2012 CHTS, neighborhood land use characteristics by scenario planning zones (SPZs), and neighborhood built environment and active transportation infrastructures by SPZs were input to the SPM-AT tool to calculate the changes in mode share and the number of trips by mode by different active transportation infrastructure inputs. SCAG assumed the reduction of vehicle trips and VMT associated with active transportation enhancement programs would be equal to the increased trips and travel distance by non-motorized mode.

Table 12 summarizes the VMT reduction from the increase walk, bike and transit trips associated with active transportation enhancement. This reduction of VMT can be translated into 0.52 percent VMT reduction in the SCAG region in 2040.

Table 12: VMT Reduction from Active Transportation Enhancement

Non-Auto Mode	Trips Increased	Average Trip Length[29]	VMT Reduction[30]
Walk	1,747,645	0.5	582,548
Bike	574,810	2.5	958,017
Transit	194,363	6.0	777,452
Total			**2,318,017**

[29] Average trip lengths were estimated based on the 2012 CHTS.

[30] VMT reduction = trips increase X trip length / 1.5 (average vehicle occupancy)

Zero Emission Vehicles

SCAG will continue to support zero emissions vehicle (ZEV) rebates, assist local jurisdictions in seeking grant opportunities for ZEV charging and refueling stations, and promote local and regional efforts to implement workplace and multi-family housing PEV charging stations. SCAG applied the methodology developed by MTC[31] to estimate the GHG emissions reductions that would result from enhancing the regional network of charging stations. The 2016 RTP/SCS will support enough charging stations (e.g. 380,000 new EV charging stations focused on workplaces and multi-family housing units in urban and compact areas) to increase the PHEV usage of electricity by ten percent.

Neighborhood Electric Vehicle (NEV) Policies

This strategy is intended to encourage the use of alternatives to full size internal combustion engine vehicles for short trips in areas not served by high quality transit. In the SCAG region, 38 percent of trips are less than three miles. The goal of this strategy is to replace 1.5 percent of all auto trips less than three miles with NEV trips in neighborhood mobility areas (NMAs). To quantify the benefits of this strategy, SCAG prepared GIS maps of the region indicating areas with suitable local connectivity conducive to people walking, bicycling, and using low speed electric vehicles such as NEVs for trips under three miles. SCAG relied on the methodology documented by CAPCOA[32].

Shared Mobility Supportive Polices

SCAG's 2016 RTP/SCS contains policies to support greater use of shared mobility services including car sharing, peer-to-peer car sharing, ridesourcing, dynamic on-demand private transit, vanpool and private employer charters, and bike sharing. Table 13 summarizes the region's goals for penetration of these alternative mobility services. SCAG's VMT reduction assumptions from participating households are based on empirical data noted by CAPCOA and in ARB policy briefs[33]. SCAG estimated the implementation of car sharing and ridesourcing will contribute to a 0.36% and 0.56% VMT reduction, respectively.

---

[31] MTC (2013). EV-related strategies baseline calculation tool created by ICF International (May 2013)

[32] California Air Pollution Control Officers Association, *Quantifying Greenhouse Gas Mitigation Measures*, Aug. 2010, <http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf>

[33] Handy, S., M. Boarnet, et al., Transportation and Land Use Policy Briefs, <http://arb.ca.gov/cc/sb375/policies/policies.htm>.

Table 13: Policy Goals of Participating Households in 2040

	Car Sharing	Ridesourcing
Urban TAZs	15%	15%
Compact TAZs	5%	5%
Other TAZs	1%	1%
Reduction of VMT of participating households	30%	30%
VMT reduction	1,621,553	2,479,707
% VMT reduction	**0.36%**	**0.56%**

Overall Reduction from Off-Model Strategies

Table 14 summarizes the off-model adjustments for GHG emissions reductions by 2040. SCAG estimated that reductions from off-model strategies are approximately 2.1 percent per capita by 2035, and 2.4 percent per capita by 2040. ARB staff reviewed SCAG's quantification methodology and found it to be consistent with the findings in empirical literature and the methodologies used by other California MPOs.

Table 14: Off-Model Adjustments (Percent Per Capita GHG Reduction)

Off-Model Strategy	2035	2040
Active Transportation	0.4%	0.5%
Zero Emission Vehicles	0.8%	1.0%
Neighborhood Electric Vehicles	0.01%	0.01%
Shared Mobility Supportive Policies	0.8%	0.9%
Total	**2.1%**	**2.4%**

C. EMFAC Model

ARB's Emission Factor model (EMFAC) is a California-specific computer model that calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses. EMFAC is used to support ARB's regulatory and air quality planning efforts and to meet the Federal Highway Administration's transportation planning requirements. SCAG used EMFAC 2014[34], which was the approved version of EMFAC available at the time the Draft RTP/SCS was released. SCAG converted the estimated passenger vehicle VMT and speed profiles into EMFAC 2014 inputs, and

[34] More information about EMFAC 2014 can be found here: http://www.arb.ca.gov/msei/categories.htm.

then calculated per capita CO_2 emissions by using residential populations and estimated CO_2 emissions for passenger vehicles in 2020 and 2035.

ARB staff developed a *Methodology to Calculate CO_2 Adjustment to EMFAC Output for SB 375 Target Demonstrations* to allow MPOs to adjust the calculation of percent reduction in per capita CO_2 emissions used to meet the established targets when using a different version of EMFAC for the region's second RTP/SCS. This adjustment factor neutralizes the changes in fleet average emission rates between the version of EMFAC used for the 2012 RTP/SCS (in SCAG's case, EMFAC 2011) and the version used for the 2016 RTP/SCS (EMFAC 2014). The goal of the methodology is to hold each MPO to the same level of stringency in achieving their targets, regardless of the version of EMFAC used for its second SCS. SCAG followed the methodology and their CO_2 per capita reductions results were adjusted accordingly.

D. Planned Modeling Improvements

SCAG continues to enhance the quality of the analytical tools it uses to inform regional decision makers. SCAG is currently developing its next generation models and tools, including an activity-based model (ABM) and a land use model, which will be used in development of the region's 2020 RTP/SCS.

The ABM uses an integrated framework to address the complex interactions between travel activity and behavior. When final testing is complete, SCAG's ABM should be able to model the activity-travel patterns of workers as well as non-workers in a household. SCAG's AMB is being designed to take various inputs like land use, socioeconomic characteristics, and the transportation system, and provide outputs of the complete daily activity travel patterns for each individual in the household. SCAG plans to conduct a peer review for the ABM and model validation for the year 2016.

SCAG is also developing an enhanced land use model, intended to predict economic activity associated with land use as a result of changes in transportation investments and policies. The land use mode will be integrated with the ABM, and the effects of transportation and land use policy changes will be evaluated through interactions between variables and a feedback mechanism.

The ABM will be used for the 2020 RTP/SCS; however, SCAG will continue to maintain and enhance the existing trip-based travel demand model for consultant, subregional, and local jurisdiction use. SCAG will also enhance and improve modeling components for the SPM-AT, Heavy Duty Truck Model, and growth forecasting models.

III. Model Sensitivity Analysis

Sensitivity analyses help to understand the responsiveness of the travel demand model to changes in selected input variables, and whether the model can reasonably anticipate changes in VMT and associated GHG emissions resulting from SCS policies.

Because SCAG used the same travel demand model that it used for the 2012 RTP/SCS, ARB staff's prior assessment of the model's sensitivity is still current (refer to the ARB's technical evaluation of SCAG's 2012 RTP/SCS). However, to support the 2016 RTP/SCS, ARB staff requested that SCAG conduct three additional sensitivity tests not conducted in 2012:

- High Occupancy Toll (HOT) Pricing
- Vehicle-miles Traveled (VMT) Fee
- Land Use

A. High Occupancy Toll (HOT) Pricing

High Occupancy Toll (HOT) pricing is a type of roadway pricing which allows use by single occupant vehicles that pay a toll. HOT pricing allows more vehicles to use High Occupancy Vehicle (HOV) lanes while maintaining an incentive for mode shifting and raising revenue. SCAG used two scenarios to examine the responsiveness of the model to changes in HOT pricing (i.e. 50 percent decrease, and 200 percent increase from the base case).

There are 860 HOT lane-miles planned in the 2016 RTP/SCS, with average toll fee ranging from three cents per mile at night to fifty cents per mile in the PM peak period. Low tolls on HOT lanes are expected to cause an increase in auto trips and a decrease in transit mode share, and vice versa.

Table 15 summarizes the change in mode share from base case for home based work (HBW) trips and all other trip purposes combined. Though the mode share changes are very small, the direction of the change is as expected. For HBW trips, there are less SOV trips and more HOV and transit trips when the HOT fee increases, and vice versa.

Table 15: HOT Pricing – Changes in Mode Share

Mode	50 percent decrease from Base Case	200 percent increase from Base Case
HBW Trip Purpose		
SOV	0.38%	-0.22%
HOV	-1.09%	0.83%
Transit	-1.07%	0.40%
Other Trip Purposes Combined		
SOV	0.09%	-0.03%
HOV	0.00%	0.00%
Transit	-1%	1%

Table 16 shows the changes in VMT at selected corridors in the region in response to the change in HOT fee. Though the magnitude of the change is different from corridor to corridor, the directionality of the change in VMT is consistent. When the HOT fee increased, VMT at all selected corridors decreased. The widely variable magnitude of change in VMT at various corridors may be due to traffic volume and existing capacity on those corridors.

Table 16: HOT Pricing – Changes in Corridor Level VMT

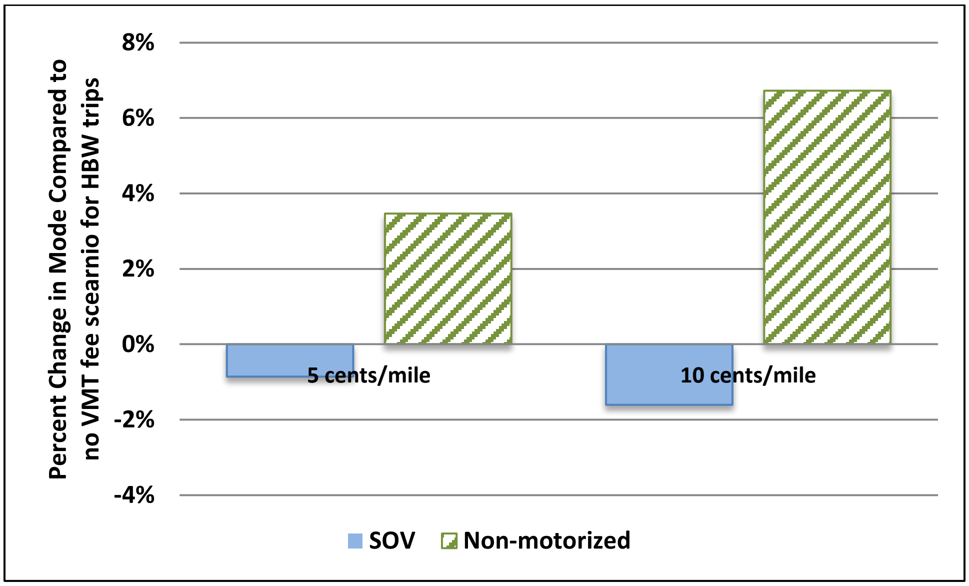
Selected Corridor	50 percent decrease from Base Case	Base Case	200 percent increase from Base Case
I-10, VMT	748,000	578,000	327,000
% in VMT	29%	--	-43%
I-15, VMT	866,000	834,000	773,000
% in VMT	4%	--	-7%
I-605, VMT	201,000	151,000	61,000
% in VMT	33%	--	-60%
Note: VMT is expressed in thousands			

B. Vehicle Miles Traveled (VMT) Fee

A VMT fee is a distance-based fee charged on a vehicle user for use of a roadway system. Road user pricing can be considered a travel demand management (TDM) measure. These measures include policies that are designed to affect the amount, time, or place that people travel. When the VMT fee increases, for example, it is expected that drivers would make less trips, and/or shorter trips, or take another less expensive mode to save money.

SCAG tested three scenarios to determine the model's responsiveness to changes in VMT fee: zero cents per mile, five cents per mile, and ten cents per mile. Figure 3 shows the percent change in SOV and non-motorized mode share for HBW trips. As expected, SOV roadway users switch to HOV and transit mode in response to VMT fee increases. The trend is also consistent for all other trip purposes combined: as VMT fee increases there are less SOV trips and more non-motorized trips. The test results demonstrate that SCAG's model produces a consistent and appropriate forecast of the impact of a VMT fee policy on regional travel.

Figure 3: Change in Mode Share Compared to No VMT Fee Scenario



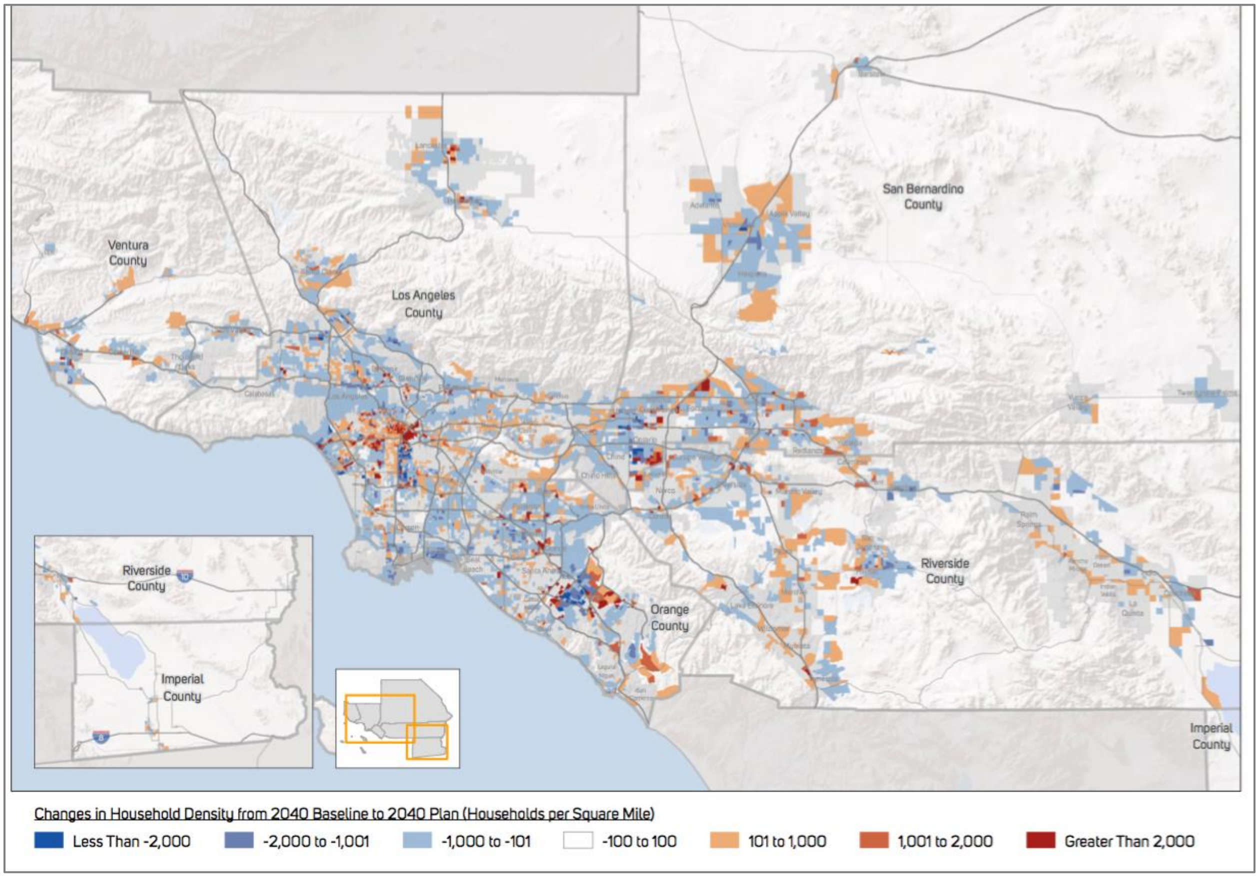
C. Land Use

Land use factors such as density, regional accessibility, mix of uses, and roadway connectivity affect travel behavior, including per capita VMT, mode share and non-motorized travel.[35] SCAG tested two scenarios for calendar year 2040, the base case and higher density, to examine the model's responsiveness to change in land use and growth projections. In the base case scenario, growth would continue to occur on undeveloped lands with a greater share of single-family housing in suburban areas. The

[35] Litman, Todd & Rowan Steele. (2016) Land Use Impacts on Transport: How Land Use Factors Affect Travel Behavior. Victoria Transport Policy Institute. http://www.vtpi.org/landtravel.pdf.

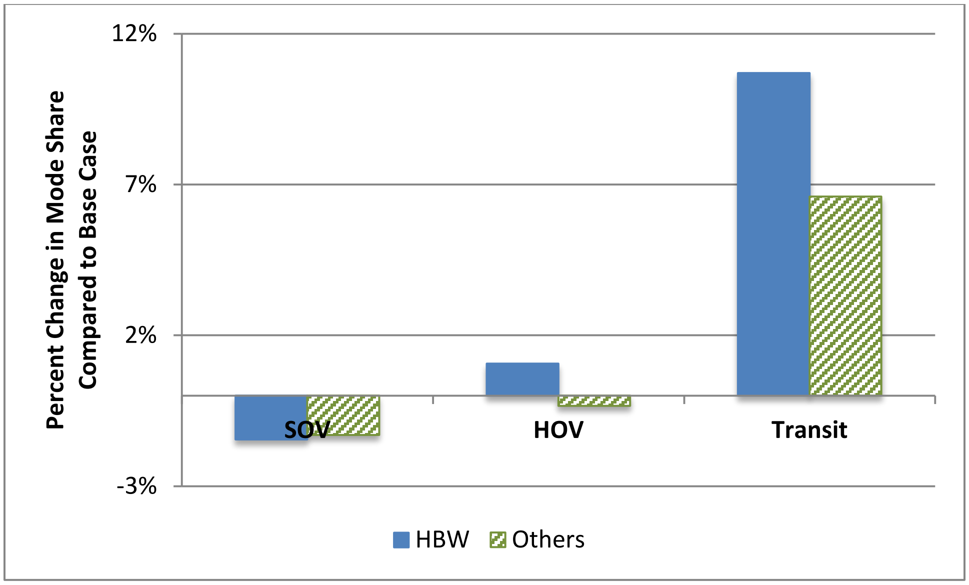
higher density scenario emphasizes growth of multi-family housing units in the high quality transit areas (HQTA). The higher density scenario assumes 67 percent of new housing would be multi-family units versus 36 percent in the base case scenario. Figure 4 illustrates the geographical changes of new housing development and density in HQTAs.

Figure 4: Changes in Household Density from Base Case to Higher Density Scenario



As expected, the higher density scenario produces an increase in transit mode share and a decrease in vehicle trips and VMT. Compared to the base case scenario, regional VMT decreases by 0.7 percent in the higher density scenario. Also for both HBW trips and all other trip purposes, there are less SOV trips because more people share rides and utilize public transit service (Figure 5).

Figure 5: Changes in Mode Share from Base Case in 2040 to Higher Density Scenario



APPENDIX B. SCAG'S MODELING DATA TABLE

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
DEMOGRAPHIC							
Total population (000s)	18,318	19,390	19,389	21,481	21,480	22,132	22,132
Group quarters (000s)	316	330	330	356	356	366	366
Total number of households (000s)	5,883	6,413	6,413	7,170	7,170	7,410	7,410
Persons per household	3.06	2.97	2.97	2.95	2.95	2.94	2.94
Auto ownership per household	1.94	1.89	1.89	1.83	1.83	1.80	1.80
Total number of jobs (000s)	7,436	8,503	8,503	9,568	9,568	9,868	9,868
Average unemployment rate (%)[3]	11%	5%	5%	5%	5%	5%	5%
Median household income ($2011)	57,584	57,584	57,584	57,584	57,584	57,584	57,584
LAND USE							
Total acres within MPO	24,716,735	24,716,735	24,716,735	24,716,735	24,716,735	24,716,735	24,716,735
Total resource area acres (CA GC Section 65080.01)[4]	15,296,962	N/A[5]	N/A	N/A	N/A	N/A	N/A
Total farmland acres (SB375) (CA GC Section 65080.01)[6]	2,626,907	N/A	N/A	N/A	N/A	N/A	N/A
Developed acres	2,588,525	N/A	N/A	N/A	N/A	2,664,152	2,686,782
Commercial developed acres	514,139	N/A	N/A	N/A	N/A	535,137	541,420
Residential developed acres	2,074,386	N/A	N/A	N/A	N/A	2,129,015	2,145,362
Total acreage available for new development[7]	1,989,154	N/A	N/A	N/A	N/A	N/A	N/A
Housing vacancy rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total single-family detached	3,237	3,407	3,609	3,685	4,073	3,763	4,208

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
households (000s)							
Total small lot single family detached households (5,500 sq.ft lots and smaller) (000s)	1,068	N/A	N/A	N/A	N/A	1,392	1,347
Total conventional-lot single family detached households (between 5,500 and 10,900 sq.ft. lots) (000s) Total large-lot single family detached households (10,900 sq ft. lots and larger) (000s)	2,169	N/A	N/A	N/A	N/A	2,371	2,861
Total single-family attached households (000s)	432	489	457	556	496	577	509
Total multi-family households (000s)	2,014	2,278	2,126	2,615	2,333	2,739	2,414
Total mobile home & other households (000s)	200	239	221	314	268	331	279
Total infill households (Growth Only - 2010 Base) (000s)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total mixed use acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average density - dwelling units per acre per residential land designations of General Plan (residential land, mixed use & specific Plan)	1.82	1.98	1.98	2.21	2.21	2.29	2.29
All transit stations and stops							
Total households within 1/4 mile of transit stations and stops (000s)	4,034	4,168	4,182	4,564	4,582	4,704	4,715
Total households within 1/2 mile of transit stations and stops (000s)	5,046	5,351	5,382	5,865	5,921	6,039	6,094

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
Total employment within 1/4 mile of transit stations and stops (000s)	6,147	6,729	6,773	7,406	7,514	7,613	7,739
Total employment within 1/2 mile of transit stations and stops (000s)	6,945	7,780	7,826	8,619	8,724	8,867	8,988
Transit stations and stops in HQTA							
Total households within 1/4 mile of transit stations and stops (000s)	1,771	2,433	2,307	2,768	2,505	3,165	2,580
Total households within 1/2 mile of transit stations and stops (000s)	2,209	3,031	2,884	3,448	3,128	3,999	3,219
Total employment within 1/4 mile of transit stations and stops (000s)	2,898	4,048	3,841	4,580	4,173	5,285	4,290
Total employment within 1/2 mile of transit stations and stops (000s)	3,480	4,770	4,571	5,396	4,972	6,278	5,111
Percent new housing in HQTA	N/A	43%	36%	43%	35%	50%	38%
Percent new employment in HQTA	N/A	48%	44%	47%	44%	53%	50%
Fixed guideway transit station							
Total households within 1/4 mile of transit stations and stops (000s)	95	124	104	196	117	231	120
Total households within 1/2 mile of transit stations and stops (000s)	374	482	409	704	468	798	482
Total employment within 1/4 mile of transit stations and stops (000s)	365	479	399	701	442	817	453
Total employment within 1/2 mile of transit stations and stops (000s)	867	1,184	977	1,659	1,093	1,850	1,123
TRANSPORTATION SYSTEM							
Freeway and general purpose lanes – mixed flow (lane miles)	11,048	11,411	11,122	11,716	11,131	11,731	11,131
Freeway managed lanes--HOV, HOT, Tolled, etc. (lane miles)	1,256	1,923	1,588	2,516	1,666	2,583	1,666

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
Major Arterial / Expressway (lane miles)	16,252	17,405	16,387	18,002	16,396	18,015	16,396
Minor Arterial (lane miles)	19,946	20,669	20,162	21,926	20,164	22,072	20,164
Collectors (lane miles)	16,717	17,219	16,834	18,162	16,840	18,365	16,840
Locals (lane miles)	5,649	5,649	5,659	5,660	5,662	5,666	5,662
Regular transit bus operation miles	494,422	504,039	498,424	522,036	498,424	635,540	498,424
Bus rapid transit bus operation miles	6,036	8,035	6,036	8,035	6,036	8,035	6,036
Express bus operation miles	66,501	77,565	67,268	77,566	67,268	94,089	67,268
Transit rail operation miles	33,836	56,165	42,588	96,275	44,545	106,568	44,545
Bikeway miles (Class 1-4)	3,913	4,600	4,400	11,500	6,000	12,700	6,200
Miles of sidewalk[8]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TRIP DATA							
Number of trips by trip purpose							
Home-based work	11,160,224	11,601,923	12,150,781	11,602,665	12,949,929	11,663,474	13,106,724
Home-based school	4,581,798	4,514,516	4,514,516	4,844,297	4,844,297	4,957,503	4,957,503
Home-based college	672,584	648,494	648,393	691,460	692,456	706,744	707,730
Home-based shopping	4,802,966	5,100,896	5,100,632	5,649,923	5,649,020	5,814,567	5,821,564
Home-based recreational	7,380,684	7,835,385	7,843,194	8,632,139	8,680,823	8,848,026	8,916,060
Home-based others	10,457,322	11,111,114	11,121,608	12,273,035	12,338,588	12,590,252	12,669,108
Non home-based other	14,566,092	15,458,964	15,472,523	17,024,572	17,098,220	17,465,729	17,589,278
By travel mode							
Average auto trip length (miles)	11.04	11.18	11.25	10.99	10.98	10.82	10.80
Average walk trip length (miles)	1.29	1.30	1.30	1.35	1.33	1.37	1.35

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
Average bike trip length (miles)	4.21	4.24	4.22	4.47	4.36	4.57	4.45
Average transit trip length (miles) (includes access/egress distance)	11.69	12.37	11.92	13.29	12.24	13.40	12.49
Average auto travel time (minutes)	16.83	16.43	17.20	15.34	17.19	15.07	16.95
Average walk travel time (minutes)	25.77	26.00	26.05	27.00	26.59	27.33	27.08
Average bike travel time (minutes)	25.27	25.44	25.29	26.82	26.19	27.41	26.70
Average transit travel time (minutes) (includes access/egress time and wait time)	71.36	70.74	71.77	70.97	72.73	69.38	73.27
PERCENT PASSENGER TRAVEL MODE SHARE (whole day)							
SOV	41.94	42.16	42.80	40.22	42.02	39.38	41.40
HOV	43.31	43.17	42.81	44.14	43.22	44.37	43.52
HOT[9]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Public transit (Regular Bus)	1.37	1.32	1.32	1.45	1.40	1.65	1.45
Public transit (Express Bus)	0.06	0.06	0.06	0.07	0.07	0.09	0.07
Public transit (BRT)	0.03	0.04	0.03	0.04	0.03	0.05	0.03
Public transit (Rail)	0.59	0.76	0.63	0.97	0.65	1.07	0.66
Non-Motorized: Bike	1.28	1.26	1.25	1.37	1.31	1.42	1.35
Non-Motorized: Walk	10.58	10.44	10.32	10.95	10.54	11.19	10.74
PERCENT PASSENGER TRAVEL MODE SHARE (peak period)							
SOV	39.77	39.90	40.68	37.72	39.85	36.84	39.21

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
HOV	44.18	44.11	43.66	45.27	44.08	45.52	44.38
HOT	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Public transit (Regular Bus)	1.55	1.49	1.49	1.63	1.59	1.84	1.65
Public transit (Express Bus)	0.07	0.08	0.07	0.09	0.08	0.11	0.09
Public transit (BRT)	0.03	0.04	0.03	0.04	0.03	0.05	0.03
Public transit (Rail)	0.85	1.09	0.90	1.40	0.94	1.53	0.97
Non-Motorized: Bike	1.29	1.26	1.25	1.35	1.30	1.39	1.34
Non-Motorized: Walk	11.07	10.91	10.81	11.37	11.03	11.60	11.23
VEHICLE MILES TRAVELED (000s)							
Total VMT per weekday (all vehicle class) (miles)	447,591	471,575	491,429	497,439	539,469	502,829	546,637
Total SB375 VMT per weekday (excluded XX VMT) (miles)	414,953	432,806	452,615	442,823	485,085	442,296	486,305
Total LM VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2, MCY and MDV) (miles)[6]	417,168	435,210	455,129	445,309	487,811	444,768	489,026
Total II (Internal) LM VMT per weekday for passenger vehicles (miles)	382,985	399,604	417,122	399,284	436,247	394,757	433,575
Total IX/XI LM VMT per weekday for passenger vehicles (miles)	31,447	32,898	35,021	42,810	47,976	46,625	51,642
Total XX LM VMT per weekday for passenger vehicles (miles)	2,736	2,708	2,987	3,215	3,587	3,386	3,810
CONGESTED TRAVEL MEASURES (000)							

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
Congested Peak Hour VMT on freeways (AM+MD+PM) (Lane Miles, V/C ratios >0.75)	111,460	113,049	128,964	109,126	146,624	107,413	147,430
Congested Peak VMT on all other roadways (AM+MD+PM) (Lane Miles, V/C ratios >0.75)	162,156	170,995	179,558	178,146	198,995	180,626	201,896
CO2 EMISSIONS (000s)							
Total CO2 emissions per weekday (all vehicle class w/ all measures) (tons)	238.3	215.7	225.1	177.3	190.9	180.8	194.7
Total SB375 CO2 emissions per weekday (excluded XX VMT) (tons)	198.9	203.7	215.0	206.7	231.5	206.6	232.7
Total LM CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV w/ all measures) (tons)	197.3	166.3	175.5	108.9	122.0	104.2	117.4
Total II (Internal) LM CO2 emissions per weekday for passenger vehicles w/ all measures (tons)	181.1	152.7	160.9	97.7	109.1	92.5	104.1
Total IX / XI trip LM CO2 emissions per weekday for passenger vehicles w/ all measures (tons)	14.9	12.6	13.5	10.5	12.0	10.9	12.4
Total XX trip LM CO2 emissions per weekday for passenger vehicles w/ all measures (tons)	1.3	1.0	1.2	0.8	0.9	0.8	0.9
INVESTMENT (in Nominal							

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
Dollars, Billions)							
Total Capital Projects	N/A	27.6	N/A	162.8	N/A	60.5	N/A
Arterials	N/A	3.3	N/A	9.6	N/A	5.5	N/A
Goods movement (includes grade separations)	N/A	7.7	N/A	54.1	N/A	13.0	N/A
High-occupancy vehicle/high-occupancy toll lanes	N/A	2.7	N/A	8.4	N/A	4.4	N/A
Mixed-flow and interchange improvements	N/A	2.5	N/A	6.6	N/A	3.0	N/A
Toll facilities	N/A	1.8	N/A	6.1	N/A	0.5	N/A
Transportation system management (including ITS)	N/A	0.9	N/A	5.4	N/A	2.9	N/A
Transit	N/A	6.4	N/A	34.0	N/A	15.7	N/A
Passenger rail	N/A	0.8	N/A	27.0	N/A	10.8	N/A
Active transportation	N/A	0.8	N/A	5.4	N/A	2.0	N/A
Transportation demand management	N/A	0.2	N/A	4.1	N/A	2.6	N/A
Other (includes environmental mitigation, landscaping, and project development costs)	N/A	0.5	N/A	2.0	N/A	0.2	N/A
Total Operations and Maintenance	N/A	30.8	N/A	161.9	N/A	82.3	N/A
State highways operations	N/A	9.0	N/A	38.4	N/A	18.0	N/A
Transit operations	N/A	18.5	N/A	91.3	N/A	46.9	N/A
Passenger rail operations	N/A	1.6	N/A	9.1	N/A	5.0	N/A
Regionally significant local streets and roads* operations	N/A	1.7	N/A	23.1	N/A	12.4	N/A
Debt Service	N/A	4.9	N/A	18.8	N/A	7.0	N/A
Total Cost	N/A	63.3	N/A	343.5	N/A	149.8	N/A
TRANSPORTATION USER COSTS AND PRICING							

Modeling Parameters	2012 (base year)	2020		2035		2040	
		Plan[1]	Baseline[2]	Plan	Baseline	Plan	Baseline
Vehicle operating costs (cents per mile; year 2011 constant $)	26.78	26.04	25.03	30.83	28.03	33.00	30.20
Gasoline price ($2011 per gallon)	4.00	4.24	4.24	5.03	5.03	5.44	5.44
Parking price ($ per day)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Toll price ($)	N/A	N/A	N/A	appx. $0.20 to $0.50 per mile on various toll facilities--depends on facility	appx. $0.20 to $0.50 per mile on various toll facilities--depends on facility	appx. $0.20 to $0.50 per mile on various toll facilities--depends on facility	appx. $0.20 to $0.50 per mile on various toll facilities--depends on facility
Congestion price ($ per mile)	N/A	N/A	N/A	0.028	N/A	0.028	N/A

[1] 2016 RTP/SCS Plan – The “Plan” scenario is generally defined as all RTP/SCS projects, including the 2016 RTP/SCS Baseline, and the future transportation system that will result from full implementation of the 2015 FTIP and the 2016 RTP/SCS
[2] 2016 RTP/SCS Baseline – The “Baseline” scenario includes all existing regionally significant highway and transit projects, all ongoing TDM or Transportation System Management (TSM) activities, and all projects which are undergoing right-of-way acquisition, are currently under construction, have completed the NEPA process, or are in the first year of the previously conforming FTIP (Fiscal Year 2015).
[3] No small area data available. It's the regional level estimate.
[4] Total acreage of publicly owned open spaces based on California Protected Areas Database (CPAD), plus the highest value habitat areas.
[5] N/A means not available.
[6] Total acreage of lands categorized as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, Farmland of Local Importance, and Grazing Land by California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP)
[7] Total acreage of currently vacant parcels that are designated for the following general plan land uses: residential, commercial, industrial, mixed uses and specific plan (Acreage information was estimated by comparing SCAG's 2012 Existing Land Use and General Plan Land Use datasets).
[8] Miles of sidewalk is not applicable because it’s not included in the transportation network of the travel demand model.
[9] HOT mode share is not available because it was included as part of the HOV mode share

APPENDIX C. CTC RTP GUIDELINES ADDRESSED IN SCAG'S RTP/SCS

This appendix lists the requirements in the California Transportation Commission's (CTC) Regional Transportation Planning (RTP) Guidelines that are applicable to the SCAG regional travel demand model, and which SCAG followed. In addition, listed below are the recommended practices from the CTC RTP Guidelines that SCAG incorporated into its modeling system.

Requirements

- Each MPO shall model a range of alternative scenarios in the RTP Environmental Impact Report based on the policy goals of the MPO and input from the public.
- MPO models shall be capable of estimating future transportation demand at least 20 years into the future. (Title 23 CFR Part 450.322(a))
- For federal conformity purposes, each MPO shall model criteria pollutants from on-road vehicles as applicable. Emission projections shall be performed using modeling software approved by the EPA. (Title 40 CFR Part 93.111(a))
- Each MPO shall quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS. (California Government Code Section 65080(b)(2)(G))
- The MPO, the state(s), and the public transportation operator(s) shall validate data utilized in preparing other existing modal plans for providing input to the regional transportation plan. In updating the RTP, the MPO shall base the update on the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity. The MPO shall approve RTP contents and supporting analyses produced by a transportation plan update. (Title 23 CFR Part 450.322(e))
- The metropolitan transportation plan shall include the projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan. (Title 23 CFR Part 450.322(f)(1))
- The region shall achieve the requirements of the Transportation Conformity Regulations of Title 40 CFR Part 93.
- Network-based travel models shall be validated against observed counts (peak- and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination. Model forecasts shall be analyzed for reasonableness and compared to historical trends and other factors, and the results shall be documented. (Title 40 CFR Part 93.122 (b)(1)(i))
- Land use, population, employment, and other network-based travel model assumptions shall be documented and based on the best available information. (Title 40 CFR Part 93.122 (b)(1)(ii))

- Scenarios of land development and use shall be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options shall be reasonable. (Title 40 CFR Part 93.122(b)(1)(iii))
- A capacity-sensitivity assignment methodology shall be used, and emissions estimates shall be based on methodology which differentiates between peak- and off-peak link volumes and speeds and uses speeds based on final assigned volumes. (Title 40 CFR Part 93.122 (b)(1)(iv))
- Zone-to-zone travel impedance used to distribute trips between origin and destination pairs shall be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes. (Title 40 CFR Part 93.122(b)(1)(v))
- Network-based travel models shall be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices. (Title 40 CFR Part 93.122 (b)(1)(vi))
- Reasonable methods in accordance with good practice shall be used to estimate traffic speeds and delays in a manner that is sensitive to the estimated volume of travel on each roadway segment represented in the network-based travel model. (Title 40 CFR Part 93.122(b)(2))
- Highway Performance Monitoring System (HPMS) estimates of vehicle miles travel (VMT) shall be considered the primary measure of VMT within the portion of the nonattainment or maintenance area and for the functional classes of urban area basis. For areas with network-based travel models, a factor (or factors) may be developed to reconcile and calibrate the network-based travel model estimates of VMT in the base year of its validation to the HPMS estimates for the same period. These factors may then be applied to model estimates of future VMT. In this factoring process, consideration will be given to differences between HPMS and network-based travel models, such as differences in the facility coverage of the HPMS and the modeled network description. Locally developed count-based programs and other departures from these procedures are permitted subject to the interagency consultation procedures of Section 93.105(c)(1)(i). (Title 40 CFR Part 93.122(b)(3))

Recommendations

- The models should account for the effects of land use characteristics on travel, either by incorporating effects into the model process or by post-processing.
- During the development period of more sophisticated/detailed models, there may be a need to augment current models with other methods to achieve reasonable levels of sensitivity. Post-processing should be applied to adjust model outputs where the models lack capability, or are insensitive to a particular policy or factor. The most commonly referred to post-processor is a “D’s” post-processor, but post-processors could be developed for other non-D factors and policies, too.
- The models should address changes in regional demographic patterns.
- Geographic Information Systems (GIS) capabilities should be developed in these counties, leading to simple land use models in a few years.

- All natural sources data should be entered into the GIS.
- Parcel data should be developed within a few years and an existing land use data layer created.
- For the current RTP cycle (post last adoption), MPOs should use their currect travel demand model for federal conformity purposes, and a suite of analytical tools, including but not limited to, travel demand models, small area modeling tools, and other generally accepted analytical methods for determining the emission, VMT, and other performance factor impacts of sustainable communities strategies being considered pursuant to SB 375.
- Measures of means of travel should include percentage share of all trips (work and non-work) made by all single occupant vehicle, multiple occupant vehicle, or carpool, transit, walking, and bicycling.
- To the extent practical, travel demand models should be calibrated using the most recent observed data including household travel diaries, traffic counts, gas receipts, Highway Performance Monitoring System (HPMS), transit surveys, and passenger counts.
- It is recommended that transportation agencies have an on-going model improvement program to focus on increasing model accuracy and policy sensitivity. This includes on-going data development and acquisition programs to support model calibration and validation activities.
- For models with a mode choice step, if the travel demand model is unable to forecast bicycle and pedestrian trips, another means should be used to estimate those trips.
- When the transit mode is modeled, the entire transit network within the region should be represented.
- Agencies are encouraged to participate in the California Inter-Agency Modeling Forum. This venue provides an excellent opportunity to share ideas and help to ensure agencies are informed of current modeling trends and requirements.
- MPOs should work closely with state and federal agencies to secure additional funds to research and implement the new land use and activity-based modeling methodologies. Additional research and development is required to bring these new modeling approaches into mainstream modeling practice.
- The travel model set should be run to a reasonable convergence towards equilibrium across all model steps.
- Simple land use models should be used, such as GIS rule-based ones, in the short term.
- Parcel data and an existing urban layer should be developed as soon as is possible.
- A digital general plan layer should be developed in the short-term.
- A simple freight model should be developed and used.
- Several employment types should be used, along with several trip purposes.
- The models should have sufficient temporal resolution to adequately model peak and off-peak periods.

- Agencies should investigate their model's volume-delay function and ensure that speeds outputted from the model are reasonable. Road capacities and speeds should be validated with surveys
- Agencies should, at a minimum, have four-step models with full feedback across travel model steps and some sort of land use modeling.
- In addition to the conformity requirements, these regions should also add an auto ownership step and make this step and the mode choice equations for transit, walking and bicycling and the trip generation step sensitive to land use variables and transit accessibility.
- Walk and bike modes should be explicitly represented.
- The carpool mode should be included, along with access-to-transit sub modes.
- Small Traffic Analysis Zones (TAZ) should be used, to increase sensitivity to infill potential near to rail stations and in Bus Rapid Transit (BRT) corridors. Parking quantity and cost should be represented in the travel model.
- The carpool mode should be included, along with access-to-transit sub modes.
- Feedback loops should be used and take into account the effects of corridor capacity, congestion and bottlenecks on mode choice, induced demand, induced growth, travel speed and emissions.
- Simple Environmental Justice analyses should be done using travel costs or mode choice log sums, as in Group C. Examples of such analyses include the effects of transportation and development scenarios on low-income or transit-dependent households, the combined housing/transportation cost burden on these households, and the jobs/housing fit.
- Household travel surveys should be activity-based and include a tour table. GPS sampling is encouraged or extra emphasis should be placed on accurate geocoding of households, workplace locations, and stops. Regions should take care in the design and data collection procedures of the survey to ensure survey results are appropriate to the type of model being utilized. Coordination with Caltrans' travel survey efforts is encouraged.

)