TCAG 2018 RTP/SCS Methodology

Introduction

The 2018 Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS) updates the current RTP/SCS adopted by TCAG in June 2014 and continues the planning vision for the Tulare County region laid out by the original Regional Blueprint in 2009. The 2018 RTP/SCS plans how the region will invest limited transportation funds to maintain, operate and improve an integrated, multi-modal transportation system that facilitates the efficient movement of people and goods. The updated plan identifies specific strategies, policies and actions, including a list of programmed and planned transportation projects affordable within the region's anticipated reasonably available transportation funding, to achieve regional goals and priorities and meet the current and future needs of the region. The planning horizon of the 2018 RTP/SCS is 2042.

The preferred scenario of this Sustainable Communities Strategy, the "Blueprint" scenario, continues the strategy and vision of the adopted 2014 plan, updating it to reflect changes to land use and transportation projects in the interim.

The Sustainable Communities Strategy recognizes the fundamental relationship between land use and transportation choices: the two components influence each other and neither component can be understood without reference to the other. The 2018 RTP/SCS meets the requirements of SB 375 and, in particular, demonstrates how the integrated land use and transportation plan achieves the region's mandated greenhouse gas emission targets for passenger vehicles.

At the same time that it meets the requirements of SB 375, the 2018 RTP/SCS builds on past efforts to move the region forward toward achievement of a broader range of goals related to the environment, mobility, social equity, health and safety, and economic vitality. The plan was shaped using a performance-based approach as required by federal transportation law that measures progress toward these plan goals. From the range of integrated land use and transportation planning options studied, the 2018 RTP/SCS designates a preferred future land use and transportation scenario that, applying quantifiable performance measures, best achieves the plan goals and meets the region's transportation needs.

In updating the plan, TCAG actively sought input from local decision-makers and communities, interested stakeholder groups, and other government agencies through an extensive public process. TCAG's 2018 RTP/SCS builds on and incorporates careful planning work at both the regional and local level. Past planning efforts by TCAG and local member agencies are on track toward regional sustainability and strive to address the region's common planning challenges. Land use changes modeled as part of the preferred scenario were developed in close coordination with TCAG member agency planning staff and build on local plans updated since the

2014 RTP/SCS was adopted, just as transportation projects were developed in close coordination with Caltrans, local public works departments, and transit providers.

TCAG's 2018 RTP/SCS integrates an analysis of population growth, land use, and housing need into the long-range transportation planning process. Thus, the combined Regional Transportation Plan & Sustainable Communities Strategy strives to address transportation planning holistically, understanding transportation patterns in the context of existing and possible future land use and housing configurations. If feasible, the forecasted development pattern for the region, when integrated with the transportation network and policies, must reduce greenhouse gas emissions from passenger vehicles to achieve State-approved targets, as well as the region's own goals.

The goal of this section is to document the technical methodology used to develop the 2018 RTP/SCS and to report on the various performance measures, metrics, and indicators used to differentiate the possible outcomes of each RTP/SCS Scenario.

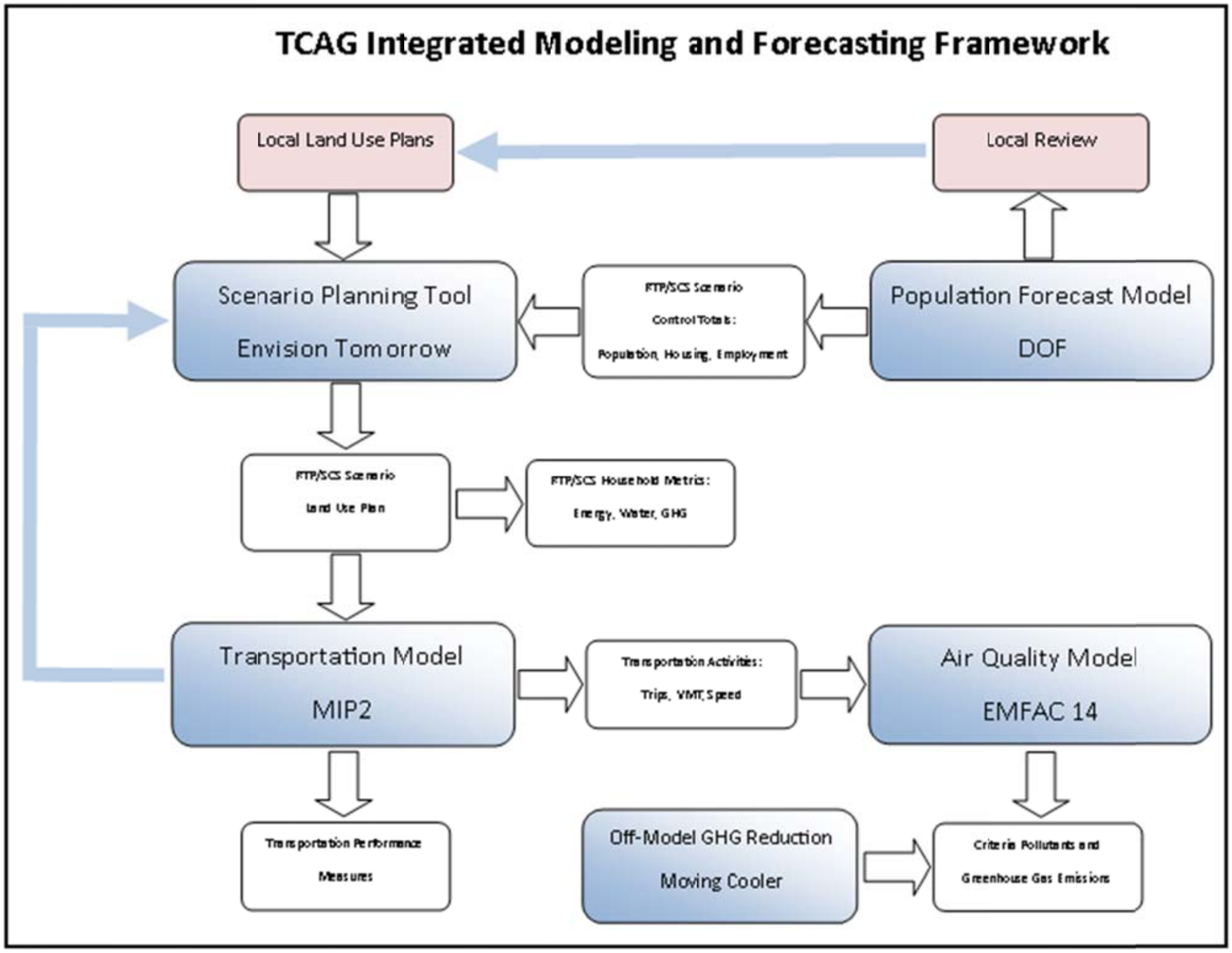
Modeling Framework

TCAG develops and applies state-of-the-art models, integrated into a comprehensive modeling and forecasting framework to develop growth projections, travel forecasts, and emissions estimates to support the Region's various planning programs. TCAG uses the same basic methodology as the big 4 MPOs in the state albeit at scale commensurate with the budget and recourses of a small MPO. (**Figure Methodology -1)** below is the TCAG Modeling Framework.

This integrated modeling and forecasting system serves as a conduit between local jurisdictions and key TCAG models by:

- Delivering locally vetted data and plans to key TCAG models for the analysis of plan performances to ensure that regional plans are consistent with local data and policy inputs; and
- Providing directional and order-of-magnitude impacts of local land use and policy decisions that will assist in the development of regional plans and associated scenario analysis.

Figure Methodology -1



Models and Tools

The TCAG utilized the following tools, similar to the big 4 MPOs, to estimate GHG emissions for the 2018 RTP/SCS, each of which are described in more detail below:

1. **Forecasting Model** - 2017 DOF Population Forecast 2015-2060
2. **Scenario Planning Tool** - Envision Tomorrow Scenario Planning/Land Use Model
3. **Transportation Model** - CUBE MIP 2 Travel Model
4. **Air Quality Model** - EMFAC 2014 Emissions Factor Model
5. Moving Cooler Off-Model Adjustments

Growth Forecast

A vital input to the SCS development process was an updated forecast of population, housing and jobs. TCAG developed a new forecast for this RTP/SCS based on the most comprehensive and up-to-date regional forecasts and projections available. The growth forecast for this RTP/SCS incorporates substantial data available from the 2010 census and new projections published by the California Department of Finance, Demographic Research Office (DOF) in 2017. The forecast for housing and jobs are based upon historic trends with the ratio of population and housing at 3.24 and the ratio of jobs to housing at 1.18 in 2042. In addition EDD and Woods & Poole employment forecasts were used to determine growth per sector. The growth forecast, based on the DOF projection, is much more restrained than in the previous RTP. The new growth forecast is summarized in (**Table Methodology-1)** below:

Table Methodology-1
Demographic Forecast

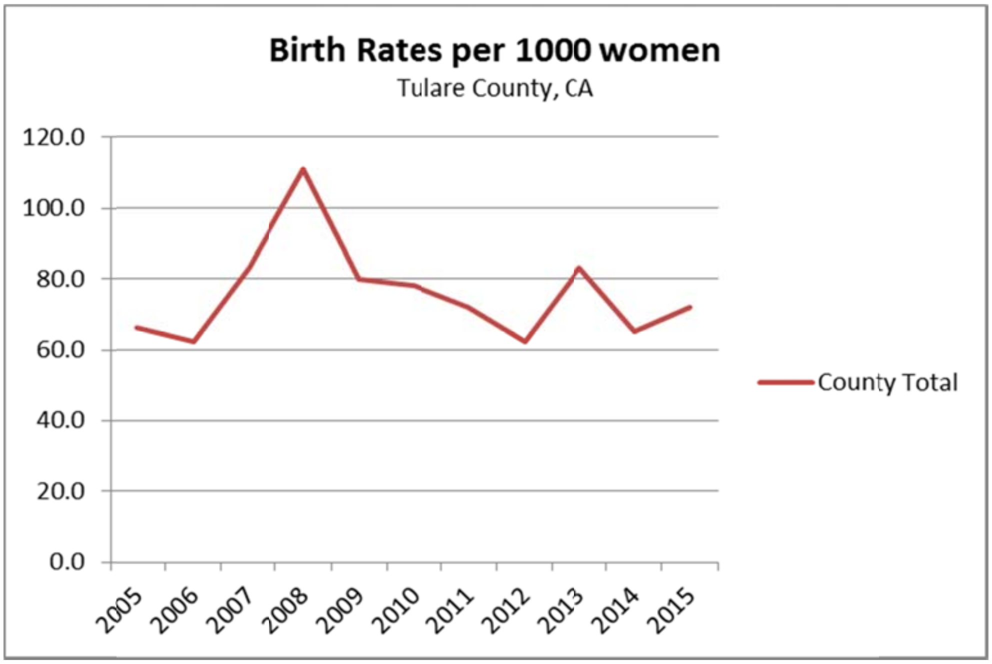
Year	Population	Housing Units	Jobs
2017	471,842	148,898	176,289
2020	488,293	153,390	181,560
2025	514,101	160,877	190,344
2030	541,140	168,364	199,128
2035	568,186	175,851	207,912
2042	604,969	186,332	220,210

The Department of Finance uses a cohort-component method to project population by age, gender, and race/ethnicity. A cohort-component method traces people born in a given year through their lives: with each passing year, new cohorts are formed by applying fertility assumptions, and the population at each age grows or shrinks due to aging, mortality, and migration assumptions.

The baseline assumptions of the projections are the continuation of changing demographic dynamics within the norm of historical experience. The projections assume that the trends described in the projections will continue irrespective of recent or anticipated legislation or policy changes. The projections are developed in consultation with local and regional authorities.

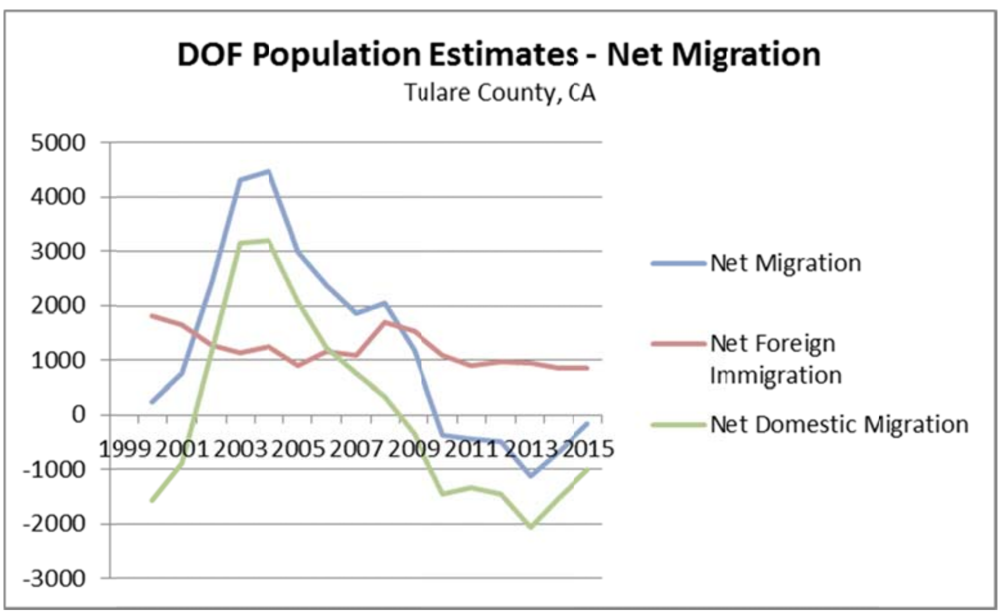
The new 2017 DOF population projection (**Figure Methodology -4**) for the year 2040 (594,348) is significantly lower than that of the 2013 DOF projection for the year 2040 (722,838) used for the 2014 RTP/SCS, a difference of 128,490 persons. This is due to lower birthrates (**Figure Methodology -2**) consistent with the state as a whole and the fact that Tulare County is still experiencing negative net migration (**Figure Methodology -3**), (-150 persons in 2015) as opposed to the peak (+4,473 persons in 2004), as a result of the Great Recession.

Figure Methodology -2



Source: U.S. Census Bureau, 2005 - 2015 American Community Survey

Figure Methodology -3



Source: Department of Finance, Population Estimates and Components of Change, 2000-2015

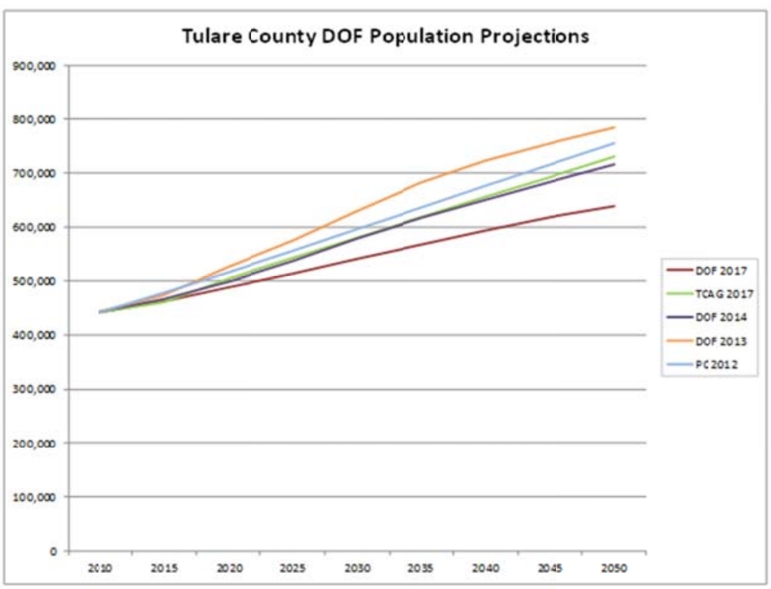
It is important to note that a significantly lower population projection for the year 2040 may make it more difficult to achieve GHG reduction targets and harder to implement higher density and mass transportation solutions. Notwithstanding, the 2018 RTP/SCS represent an equivalent effort in GHG per capita reductions as the 2014 RTP/SCS, considering updated demographics assumptions and updated modeling tools.

Figure Methodology -4 Comparison of recent DOF Projections

DOF State and County Population Projections P-1

Total Population Projections for California and Counties: 2010 to 2060 in 5-year Increments

	Estimates	Projections									
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
California	37,333,583	39,059,809	40,719,999	42,407,005	44,019,846	45,521,334	46,884,801	48,088,425	49,158,401	50,124,768	51,056,510
Tulare	442,551	463,291	488,293	514,101	541,140	568,186	594,348	617,916	639,477	569,482	679,167
Projections Prepared by Demographic Research Unit, California Department of Finance, February 2017											
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Tulare	442,179	461,589	505,164	542,816	580,724	618,485	656,003	693,121	730,043		
Projections Prepared by The Planning Center, TCAG Update January 2017											
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Tulare	443,487	467,170	498,559	537,015	578,858	616,547	650,819	683,533	715,722	747,912	779,772
Projections Prepared by Demographic Research Unit, California Department of Finance, December 2014											
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Tulare	442,179	479,763	520,542	564,787	612,792	664,878	721,391				
TCAG 2014 RTP/SCS											
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Tulare	443,066	473,785	526,718	575,294	630,303	682,022	722,838	755,809	784,334	811,412	836,850
Projections Prepared by Demographic Research Unit, California Department of Finance, January 2013											
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Tulare	442,179	478,066	516,915	556,468	596,390	636,329	676,218	715,937	755,732		
Projections Prepared by The Planning Center, June 2012											



Land Use Scenarios

Development of the SCS involved the study of distinct land use scenarios, each analyzing different combinations of land use and transportation variables. The preferred scenario was selected from these scenario options on the basis of stakeholder input and scenario performance measures tied to the overall RTP/SCS goals. All scenarios applied the same region-wide population, employment and housing projections. Sub-regional allocation of forecast population growth varies by scenario consistent with allowable land uses, residential land use capacity and policy assumptions as follows:

Trend: The Trend scenario shows a land use forecast based on designations from existing local agency general plans and linear trends in growth on a sub-regional basis. This means that the projected pattern of development will be generally consistent with the development pattern seen currently. **(Figure Methodology -5)**

Blueprint (Preferred Scenario): The Blueprint scenario **(Figure Methodology -6)** is based on the application of the development principles adopted as part of the 2009 Tulare County Regional Blueprint. Primary among these principles is an objective of 25% higher overall density for new development compared to the Trend scenario and an increased emphasis on transit and active transportation modes. The Blueprint Scenario focuses on higher densities and mix-use development along the Mooney Corridor in Visalia-Tulare and in central Porterville. **(Figure Methodology -7)** shows transit priority areas in the Visalia-Tulare UZA.

Blueprint Plus: The Blueprint Plus scenario was requested by the RTP Roundtable in 2013 to explore the ramifications of a change in future development patterns more pronounced than that envisioned by the Regional Blueprint. Blueprint Plus has an objective of overall density of new development 5% higher than Blueprint (30% higher than Trend) and a maximum feasible emphasis on transit and active transportation modes. **(Figure Methodology -8)**

Figure Methodology -5

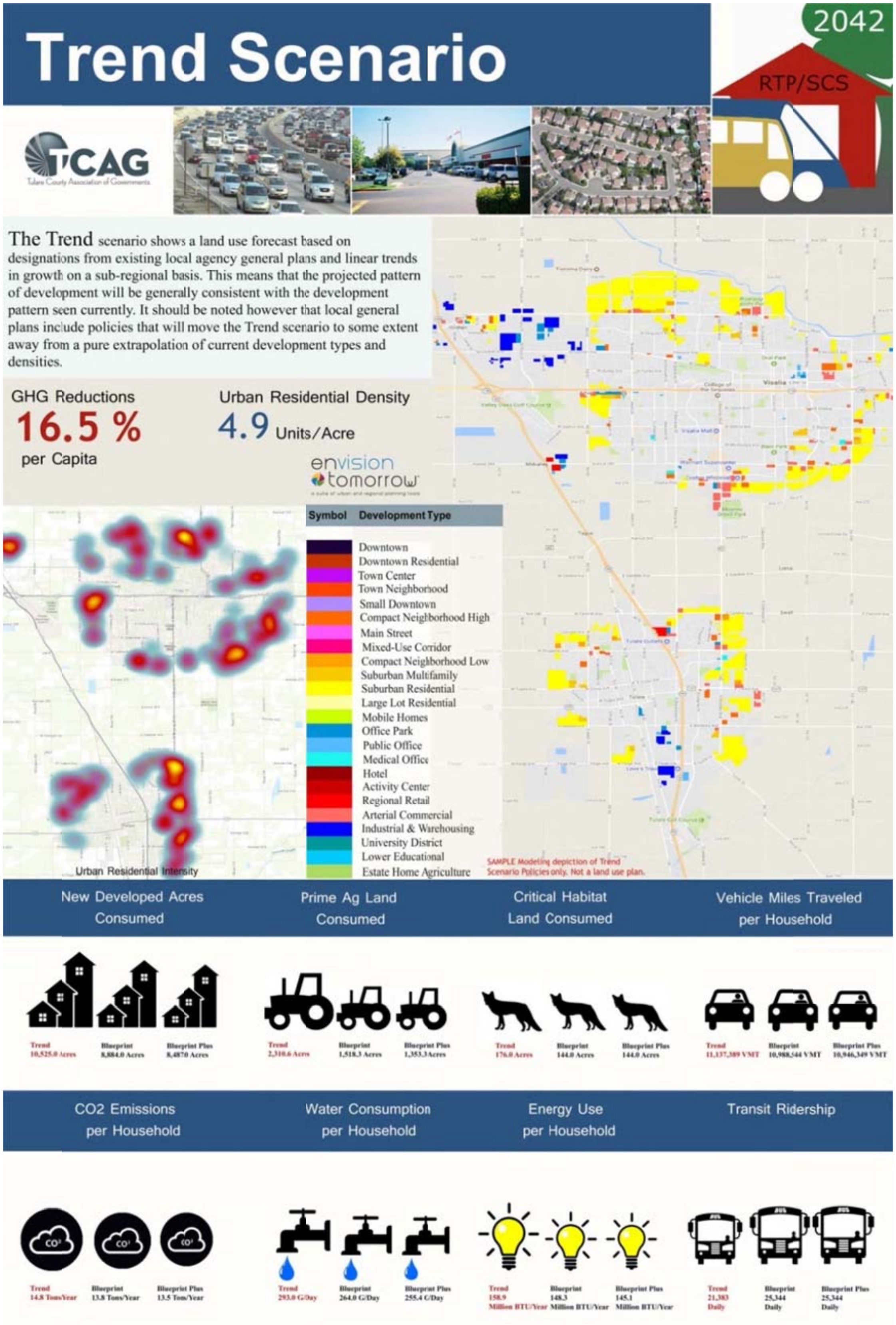


Figure Methodology -6

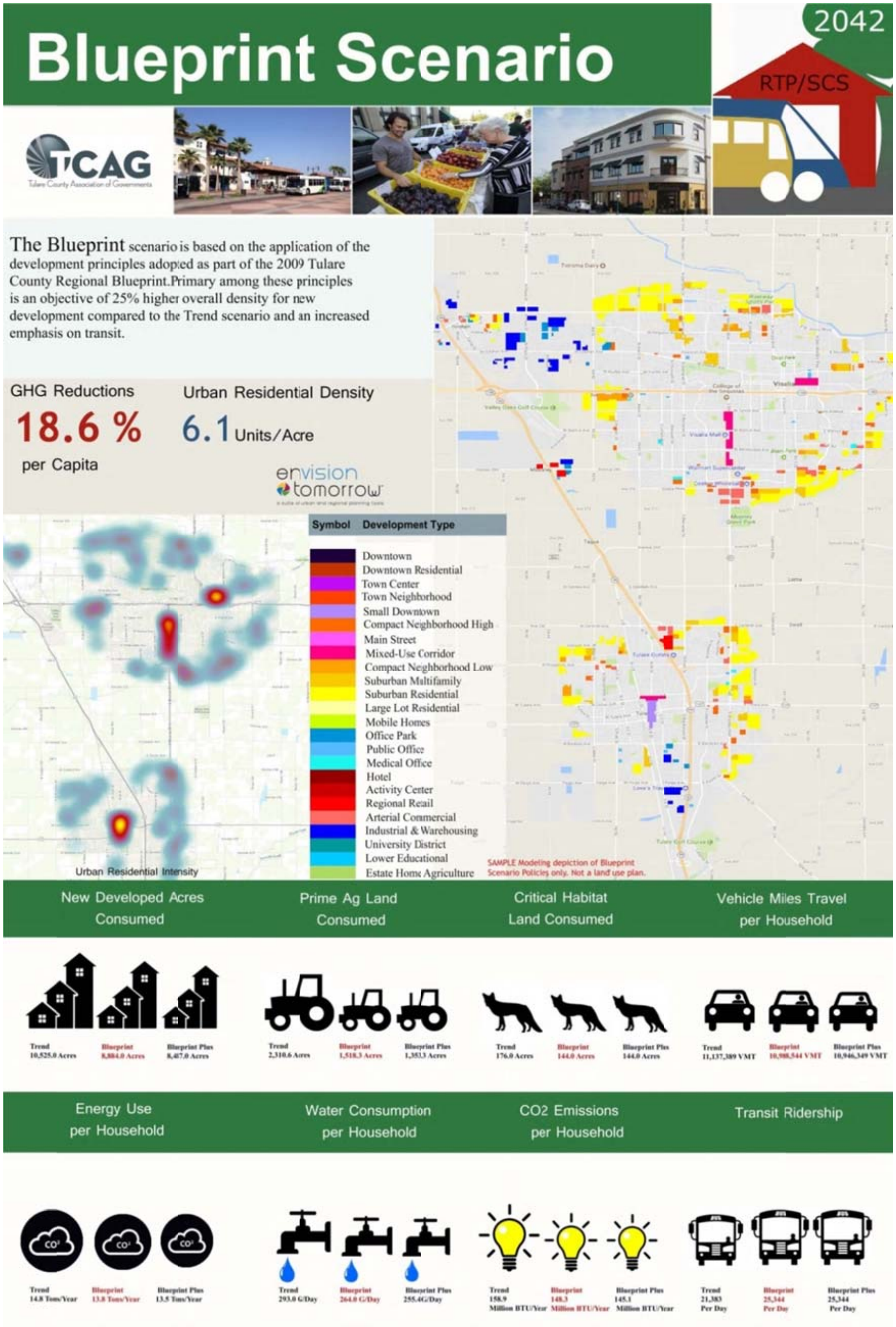


Figure Methodology -7

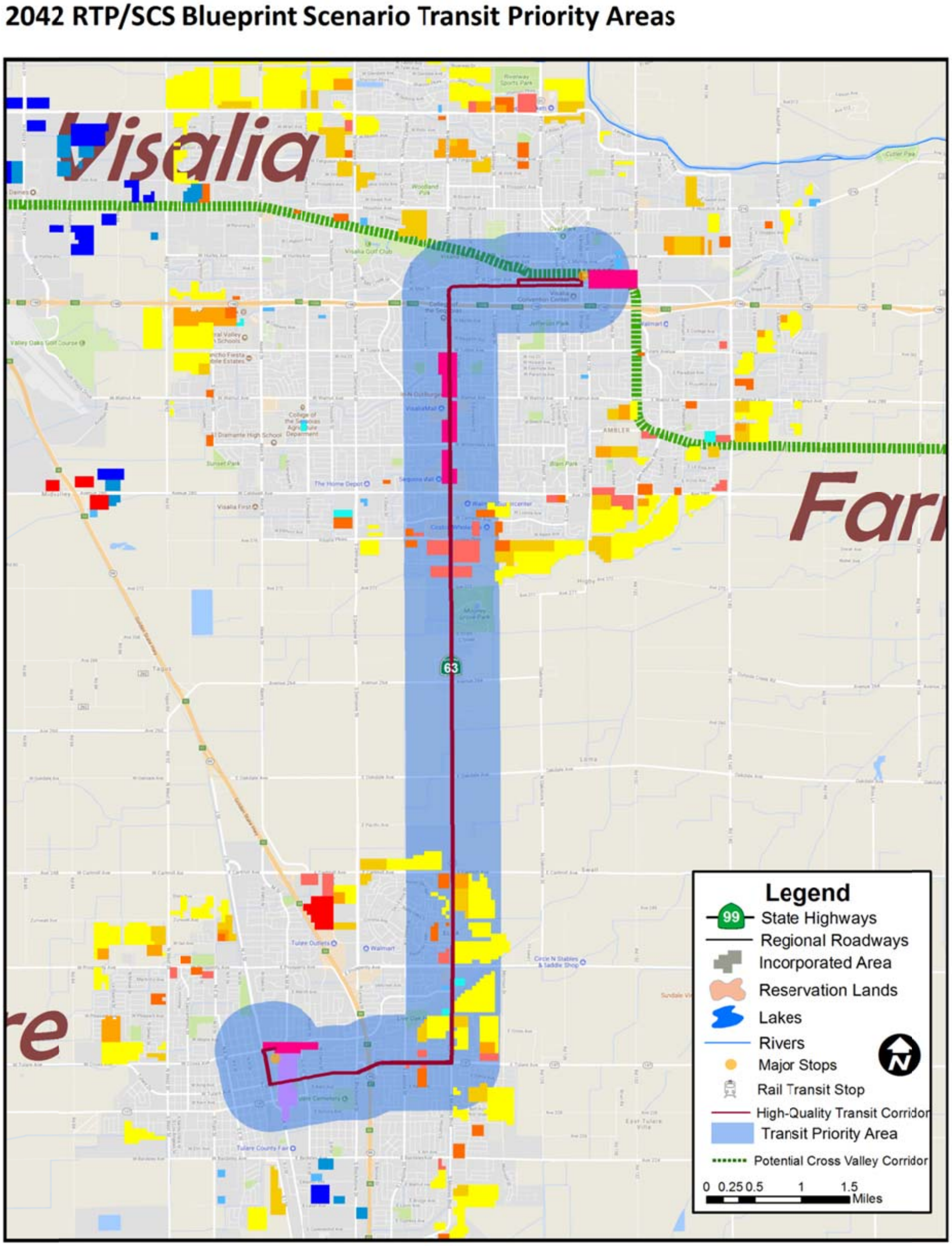
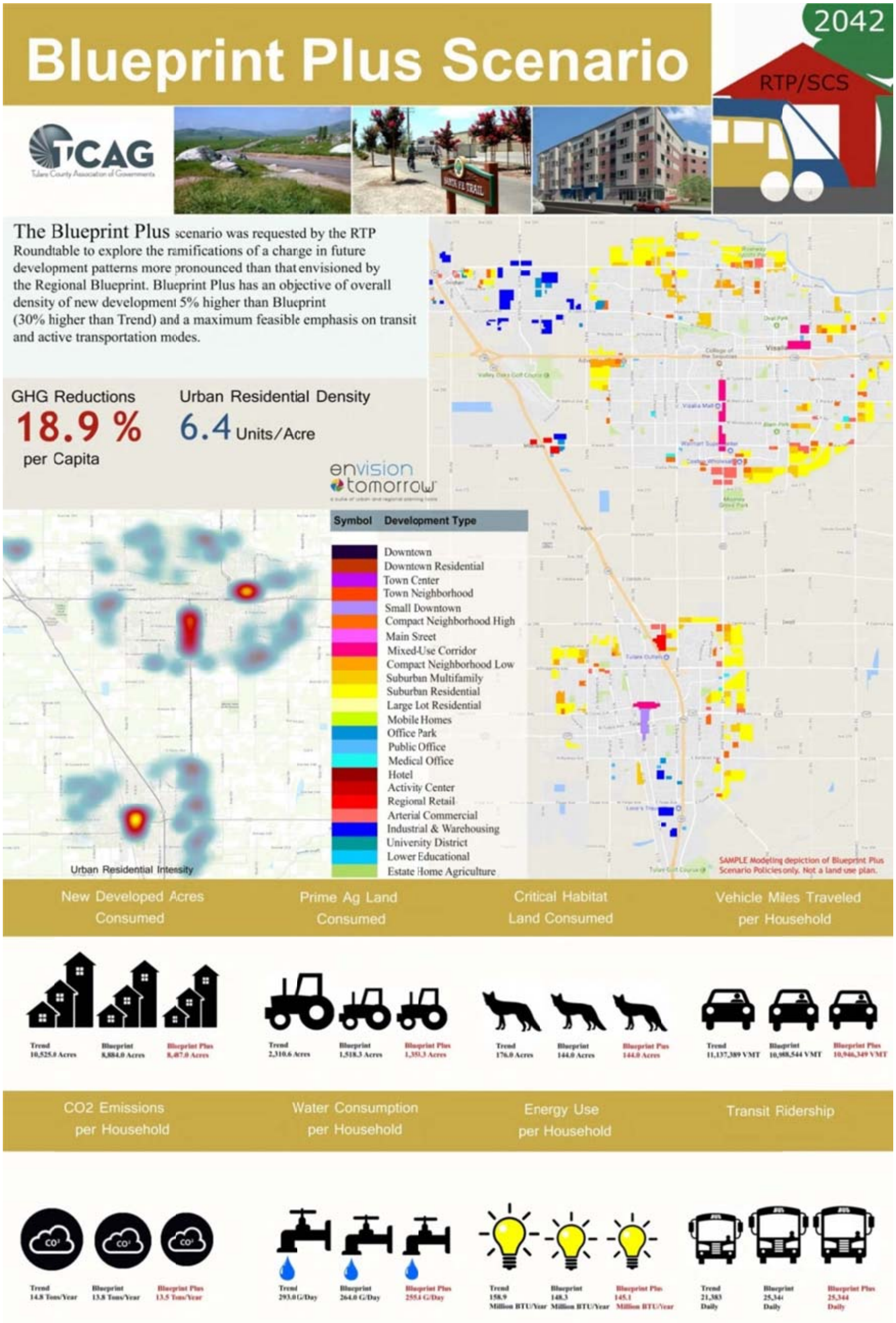


Figure Methodology -8



Envision Tomorrow

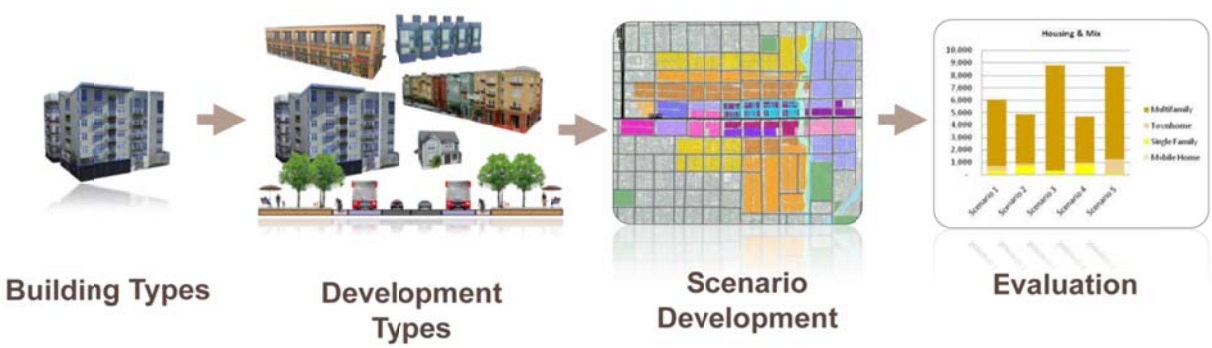
Envision Tomorrow (ET), developed by Fregonese Associates of Portland Oregon, is an open-access scenario planning package that allows users to analyze how their community's current growth pattern and future decisions impacting growth will impact a range of measures from public health, fiscal resiliency and environmental sustainability.

Envision Tomorrow v3.8.6 for ArcGIS 10.5 is a suite of planning tools that includes analysis tools and scenario design tools. The analysis tools allow users to analyze aspects of their current community using commonly accessible GIS data, such as tax assessor parcel data and Census data. The scenario painting tool allows users to "paint" alternative future development scenarios on the landscape, and compare scenario outcomes in real time.

ET provides a quick, sketch-level glimpse of the possible impacts of policies, development decisions and current growth trajectories, and can be used by communities to develop a shared vision of a desirable and attainable future. It can be applied at scales from a single parcel to a metropolitan region.

Scenario comparisons measures include a comprehensive range of indicators relating to land use, housing, demographics, economic growth, development feasibility, fiscal impacts, transportation, environmental factors, and quality of life. Envision Tomorrow can be downloaded at http://envisiontomorrow.org/downloads/.

Figure Methodology -9



The eight San Joaquin Valley MPOs, contracted with Fregonese Associates to customize the Envision Tomorrow scenario planning tool for the condistions of the San Joaquin Valley for the 2014 RTP/SCS. Building Types that range from 10 story office buildings downtown to a typical suburban house were developed. These Building Types are very specific with everything from building height to floor area ratio to parking requirements and other ammenties associated with actual building structures. Several Development Types are then defined as the combination of Building Types typically found within common planning designations like Mixed-use, Commercial, Industrial, Suburban Residential, and Multi-family Residential for example. Control totals for each community for population, housing, and employment for the year 2042 are used to guide the "painting" of Development Types in one acre squares in a GIS environment for the TCAG region during Scenario Development **(Figue Methodology-9)**. Envision Tomorrow painted GIS scenarios are synced to the ET Scenario Builder Spreadsheet v3.7.6 which calculates performance metrics for evaluation. For the 2018 RTP/SCS TCAG utilized the following Envision Tomorrow metrics to help with scenario evaluation:

- **Urban Gross Residential Density**
  Urban Gross Residential Density is calculated by the number of housing units per acre including neighborhood level infrastructure like local streets but does not include arterial streets, parks, schools or other uses besides residential development. A core tenant of TCAG's Blueprint Scenario is policy for a 25% increase in urban residential density from the Trend Scenario.

- **New Developed Acres Consumed**
  New Developed Acres Consumed is calculated based upon the Development Types used in painting each scenario based upon the control totals for population, housing and employment for 2042. This includes most types of housing and employment but does not include parks, schools, and other types of open space.

- **Important Agricultural Land Comsumed**
  Important Ag land Consumed is calculated acres consumed by overlaying the ET Scenario on to the Farmland Mapping & Monitoring Program (FMMP) GIS map. Important Farmland as defined in the RTP Guidelines as acres consumed outside the Sphere of Influence (SOI). FMMP maps can be downloaded at *http://www.conservation.ca.gov/dlrp/fmmp*.

- **Critical Habitat Land Consumed**
  Critical Habitat Land Consumed is calculated by overlaying the ET Scenario on to the San Joaquin Valley Green Print GIS Map. The San Joaquin Valley Greenprint, developed by the Information Center for the Environment at UC Davis, is a voluntary, stakeholder-driven project that provides agricultural, water, and environmental leaders with improved planning data and fosters regional collaboration on strategies that prioritize resource sustainability while enhancing economic prosperity. It focuses on the challenges and opportunities in non-urban land use planning, and how those rural decisions shape the region's economy and environment. SJV Greenprint maps can be downloaded at *http://sjvgreenprint.ice.ucdavis.edu/content/greenprint-maps*.

- **CO2 Emissions per Household**
  CO2 Emissions per Household is calculated directly in the ET Scenario Builder Spreadsheet v3.7.6 which is reported in CO_2 tons per year as correlated to the energy use of the average scenario household using data from a U.S. Energy Information Administration (EIA) survey based upon the type and size of residential buildings. *https://www.eia.gov/consumption/residential/*.

- **Water Consumption per Household**
  Water Consumption per Household is calculated directly in the ET Scenario Builder Spreadsheet v3.7.6 which is reported in gallons per day as correlated to the water use of the average scenario household based upon the type and size of residential buildings.

- **Energy Use per Household**
  Energy Use per Household is calculated directly in the ET Scenario Builder Spreadsheet v3.7.6 which is reported in million BTUs per year as correlated to the energy use of the average scenario household using data from a U.S. Energy Information Administration (EIA) survey based upon the type and size of residential buildings. *https://www.eia.gov/consumption/residential/*.

CUBE Model Improvement Program (MIP) 2 Travel Model

Model Development

Beginning in 2010, the eight MPOs began a joint process to improve their travel demand modeling capabilities to help meet SB 375 requirements. This process, known as the San Joaquin Valley Model Improvement Program (MIP) was funded by a $2.5 million Strategic Growth Council Proposition 84 grant. Between 2010 and 2012, staff from each of the eight MPOs participated in monthly meetings with a team of technical consultants to upgrade the models and modeling processes. To enhance coordination efforts, staff from the Air Resources Board and the University of California Berkeley listened in on the monthly MIP meetings of the MPOs and technical consultants.

The MIP effort resulted in the delivery of substantially upgraded and standardized travel demand models to the MPOs in the summer of 2012. The new travel models are designed to better evaluate the types of land use and transportation policies likely to be considered in the RTP/SCSs. Sensitivity to changes in land use and travel estimates was enhanced compared to previous models by – (i) refining each models' traffic analysis zone (TAZ) system to better capture mixed-use and transit oriented development; (ii) incorporating additional socioeconomic variables such as housing units by building type, household income, housing density, employee by detailed sector, and employment density; and (iii) adding a vehicle ownership component and improved sensitivity to travel characteristics.

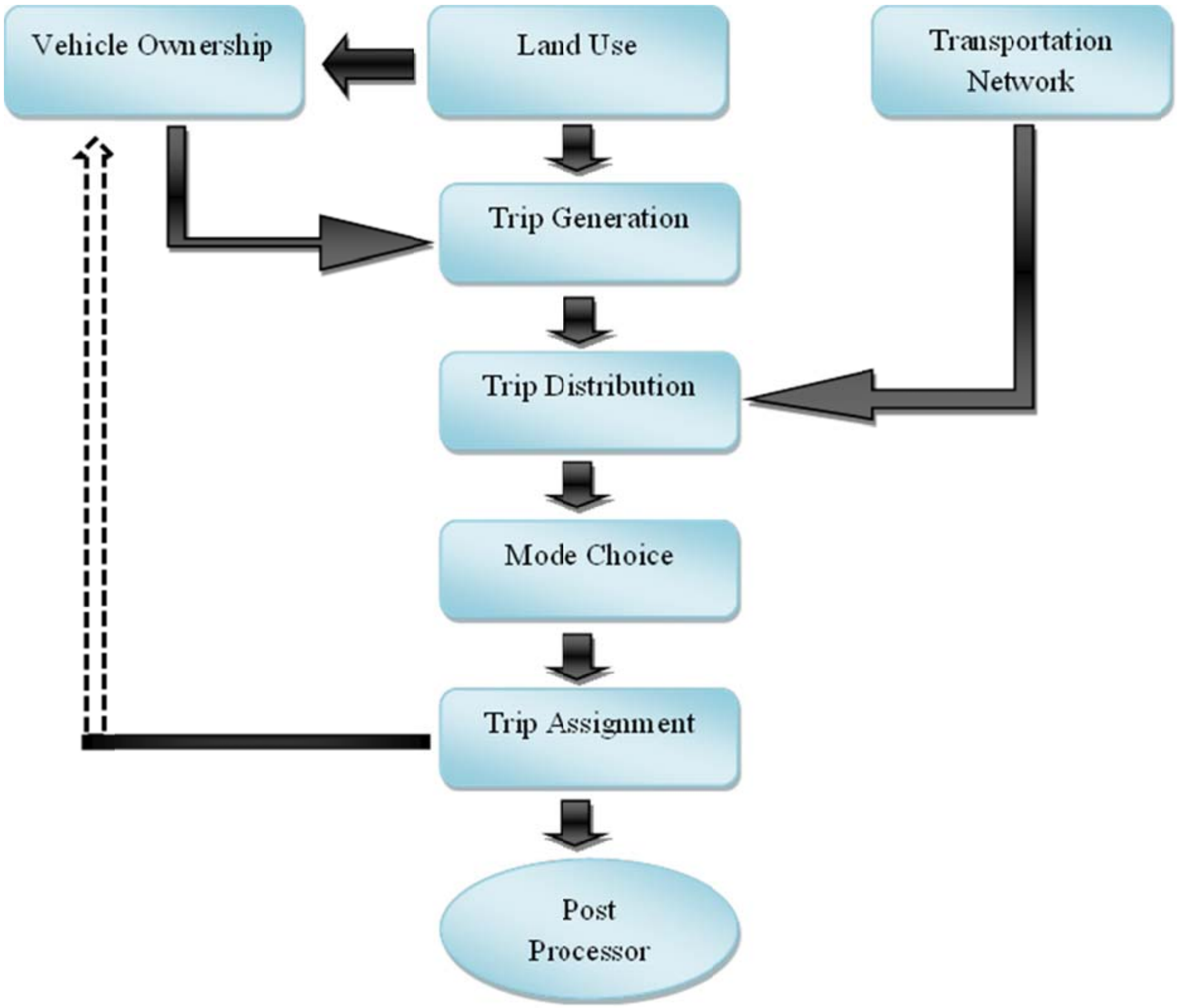
In addition, the MIP resulted in the standardization of model software, inputs, and methodologies between the eight MPOs. The new models employ a common software package called CUBE, which will enhance the MPOs' ability to share data and resources with each other, as well as coordinate on model improvement and training efforts.

Improvements made to the model input data and each of the key components of the travel demand models (**see Figure Methodology -10**) include: vehicle ownership, trip generation, trip distribution, mode choice, and trip assignment, are discussed in more detail in the following section.

Then in 2014, a minor update to the models developed in 2012 began, known as VMIP2. VMIP2 takes advantage of the 2010 Census, the most recent American Community Survey, and 2012-2013 California Household Travel Survey data, and enhances the model structure developed as part of the VMIP1. In addition to the updated data, VMIP2 implements changes to the model structure based on ARB feedback received. Model improvements that specifically address ARB's comments include the following:

- Auto ownership was updated to account for land use accessibility (auto, transit, walk, bike) and commute cost as a percentage of household income.
- Trip generation rates were revised depending on area type and accounting for the accessibility of land uses. Area type is recalculated with each model run to account for land use changes between scenarios.
- Trip distribution was updated to include correlation between household income and job salary for home-work trips.
- Mode choice was updated based on demographics from the latest household travel survey data (household size, income, autos owned) and incorporates average vehicle occupancy by purpose.
- In addition to counts and VMT, the model peak period contested locations was compared to observed NPMRDS data provided by FHWA.
- Other key enhancements to model sensitivity and usability include:
- Land Use: simplified residential and employment categories
- Socio-economic: employee salary and household income relationship for home-work trips
- Interregional Travel: updated based on the newly released California Statewide Transportation Demand Model, and based on place and purpose, rather than having internal and interregional travel combined and distributed based on time\cost of travel
- Modified Assumptions: adjustments to employment density, intersection density, and access to jobs and houses

Figure Methodology -10



Data Input: The MIP models feature improved TAZ systems, socioeconomic data, land use and travel network characteristics. Improvements to the TAZ systems are designed to help capture more detailed travel movements throughout the region, which allows for more precise analysis of land use and smart growth effects. An updated version of the trip based Caltrans statewide traffic model was developed to help forecast interregional and intraregional trips. Improvements to socioeconomic, land use and transportation network data in the models better account for differences in vehicle ownership and trip generation factors, as well as standardize categories across the eight SJV MPOs.

Vehicle Ownership: The MIP model calculates the number of motor vehicles in a region based on demographic characteristics, auto operating cost, and accessibility. The output of this component is a critical input to the trip generation step, helping to capture the economic characteristics of each household. For VMIP 2, the vehicle operating cost was updated to include maintenance and operations costs based on feedback from ARB.

Trip Generation: The trip generation component estimates the number of person-trips for each activity, such as traveling to-and-from work, school, shops, and social/recreational events. The new models estimate person trips based on demographic and employment characteristics, increasing their capability to analyze the effect of socioeconomic factors on trip rates. Further, the new models increase the number of trip purposes from the typical three or five to eleven . This change allows to distinguish the potential for alternative modes such as school and college trips. The new models also improve the trip generation step by allowing trip rates to vary by income, household size, the number of workers in a household, drivers, and vehicle ownership. This provides better information about regional travel patterns. For VMIP2, trip generation factors were updated to reflect the built environment and area type factors, and home-work trips were grouped by income range.

Trip Distribution: Trip distribution estimates the number of trips from one travel zone to each of the other travel zones in the county. The new models improve the sensitivity of changes to land use on trip distribution by better reflecting the attributes that influence a person's decision to travel. The MIP model provides the capability to consider additional factors such as trip purpose, person travel time by all modes, travel cost, congestion, and vehicle ownership. For VMIP2, trip distribution was updated to match household income and job salary and to better reflect interregional travel at a local scale.

Mode Choice: For MIP 2, TCAG included an upgraded mode choice model that includes a detailed transit network per CARB recommendation. The mode choice component is used to predict the probability of selecting a travel mode (e.g., auto, transit, bike and walk) for each trip in the region based on the income of the trip maker, the travel cost, time and accessibility of other modes, and improves the travel models' responsiveness to socioeconomic characteristics, land use, pricing and parking strategies. The mode choice model includes seven travel modes with a separate mode choice for walk and bike.

Trip Assignment: The trip assignment component estimates traffic volumes and travel times for each roadway in the network. The new models enhance the trip assignment component by including a new feedback mechanism between the trip assignment and the number of autos to enhance the ability to address induced travel demand. The feedback mechanism inputs congested travel times into the model, which helps to account for travelers who change their travel route and mode in response to congestion.

Model Calibration and Validation: A calibration and validation report for the MIP travel model will be part of TCAG final RTP/SCS submittal to ARB in the summer of 2018.

In model calibration, each component of the model is calibrated to ensure that it produces accurate forecasts. Calibration is an iterative process where model settings are adjusted so the output of the model matches observed travel patterns.

Static validation is that process where the model is tested to ensure that the model output matches available traffic counts and roadway speeds. As part of the static validation process, elements of trip generation, trip distribution and traffic assignment modules may be adjusted.

Dynamic model validation tests the model to determine how well it responds to change. Dynamic testing includes testing the changes to the following:

- Household location, density, diversity and other household attributes
- Employment location
- Roadway network
- Transit service

The MPOs performed calibration for each component of the model following the Federal Highway Administration and Caltrans guidelines, to ensure that the models produce reasonable forecasts. Model validation, a critical step in the development of any regional travel demand model, establishes the credibility of the model to predict future travel behavior. The MPOs performed both static and dynamic validation on the new models as recommended by Federal Highway Administration guidelines. Static validation includes – (i) trip generation rates, (ii) trip length frequency by purpose, (iii) average travel time by purpose, (iv) mode split by purpose, (v) traffic assignment by facility, and (vi) transit ridership. Dynamic validation included changing socioeconomic (household size, income, age distribution), land use (density, household location) and travel cost (auto operating cost and parking price) inputs.

Modeling Interregional Trips

The California Statewide Travel Demand Model (Statewide Model) was designed to capture the interactions of land use plans all across the State as they affect interregional travel. The model operates at a scale coarser than the SJV-MIP models. Its value is in placing local and regional travel in the context of total statewide activity. For the VMIP 2 update, interregional travel was updated to reflect the 2010 Statewide Model version. However, due to timing of the Statewide Model update, it does not incorporate the latest land-use from 2014 SJV RTPs.

For the VMIP2 model, AirSage data was used to evaluate county-to-county traffic volumes for the 8 SJV MPOs and aggregated volumes for counties outside of the San Joaquin Valley focusing exclusively on long distance trips. The Statewide Model was used to compare the magnitude of county-to-county traffic flows to AirSage. Once the magnitudes were determined to be comparable, the Statewide Model was used to develop through trips and station weights by purpose for each gateway. A process of interpolating or extrapolating, as appropriate, was implemented using the base and future year from the Statewide Model for multiple years. The Statewide Model was also used to determine the weighted average trip distance for external gateways to represent travel beyond the model area.

For the purpose of preparing the GHG emissions analysis for the 2018 RTP/SCSs, all emissions from through trips (trips without an origin and a destination in the MPO region) are excluded. In addition, the portion of VMT attributable to trips that either begin or end within the region but travel to/from neighboring regions (IX/XI) has been included for all portions of the trip within the MPO region.

Accounting for interregional travel, or travel that crosses MPO boundaries, continues to be a key issue for SB-375 implementation across the state. The issue is especially important when considering the area covered by SJV MPOs, which in aggregate experience a higher proportion of through traffic relative to other regions (as a percent of total vehicle miles traveled). Statewide discussions to determine how to account for interregional travel across the state should continue.

Emissions Modeling EMFAC 14

An emissions inventory is a critical element in the control of air pollution and the attainment of national and state ambient air quality standards. It is also an essential tool in developing regulations and control strategies to fulfill the Air Resources Board's (ARB) mission to promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state.

For on-road motor vehicles, emissions rates are typically expressed as mass of pollutant emitted per mile driven, per vehicle per day, or per trip made, depending on the emissions process being analyzed. An emissions process for a motor vehicle is the physical mechanism that results in the emissions of a pollutant (e.g., the combustion of fuel, the evaporation of fuel, tire or brake wear, or the start of an engine).

EMFAC2014 is the latest emissions inventory model that calculates emissions inventories for motor vehicles operating on roads in California. EMFAC2014 represents the next step forward in the ongoing improvement process for EMFAC, and reflects the ARB's current understanding of how vehicles travel and how much they pollute. The EMFAC2014 model is needed to support the Air Resources Board's regulatory and air quality planning efforts and to meet the Federal Highway Administration's transportation planning requirements.

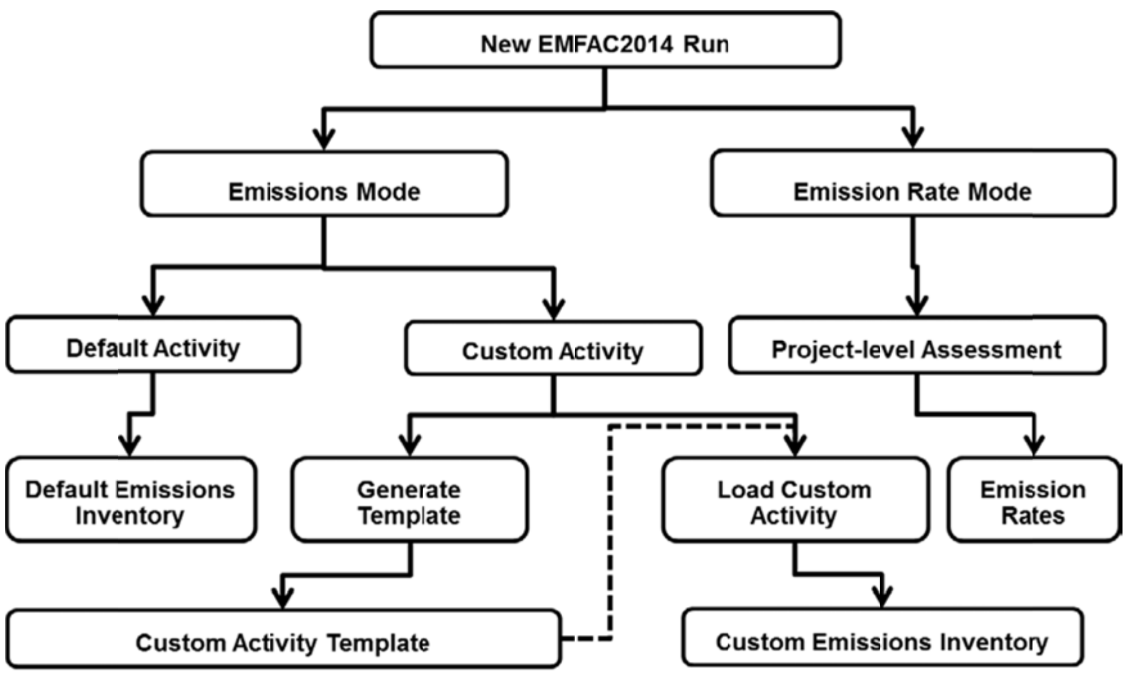
The EMFAC2014 model can be used to show how California motor vehicle emissions have changed over time and are projected to change in the future. This information helps ARB evaluate prospective control programs and determine the most effective, science-based proposals for protecting the environment. EMFAC2014 includes the latest data on California's car and truck fleets and travel activity. New forecasting methods have been incorporated for developing vehicle age distributions and estimating vehicle miles traveled. The model also reflects the emissions benefits of ARB's recent rulemakings, including on-road diesel fleet rules, Advanced

Clean Car Standards, and the Smartway/Phase I Heavy Duty Vehicle Greenhouse Gas Regulation. The model also includes updates to truck emission factors based on the latest test data. More details about the updates in emissions calculation methodologies and data are available in the EMFAC2014 Technical Support Document.

TCAG is using the latest version of ARB's emissions modeling software EMFAC2014 to complete GHG emissions estimates for the SCS scenario and the alternatives.

The latest EMFAC update includes an “SB 375 Emission Analysis” mode that estimates and reports CO2 emissions in tons per day from appropriate light-duty vehicle classes (LDA, LDT1, LDT2 and MDV). In order to ensure a coordinated approach and reduce potential for user errors, EMFAC2014 modeling instructions and EMFAC output post-processing worksheet have been developed for the SJV MPOs in consultation with ARB. The approach uses Transportation Data Templates that convert VMIP2 travel model outputs into custom EMFAC2014 inputs including total VMT and speed distributions specific to the region (**Figure Methodology -11**). Per RTAC recommendation, the VMT modeled for SB 375 purposes does not include through trips.

Figure Methodology -11



Off-Model Adjustments Moving Cooler

Similar to other traditional four-step travel demand models, the TCAG model is not sensitive to the impacts of Transportation Demand Management/Transportation Systems Management (TDM/TSM) projects such as Intelligent Transportation Systems (ITS), bike and pedestrian projects, and rideshare programs, nor electrical vehicle penetration. In these instances, TCAG relied on "off-model" adjustments using methodologies commonly used in literature, previously approved or cited by ARB, and consistent with the other MPOs.

Moving Cooler is a study commissioned by the Urban Land Institute and conducted by Cambridge Systematics to analyze the effectiveness of transportation strategies for reducing greenhouse gas emissions. Considerable research has been conducted on the role of advanced vehicle and fuel technologies in reducing the carbon footprint of transportation. However, there is less information about the potential contribution of transportation strategies to reduce the amount of vehicle travel that occurs, or to make changes to the system and services that improve fuel efficiency.

Moving Cooler provides information on the effectiveness and costs of almost 50 of these types and strategies and combination of strategies to reduce VMT. Moving Cooler focuses on two main contributors to GHG emissions:

> Travel Activity – Reducing the number of miles traveled by transportation vehicles, or shifting those miles to more efficient modes of transportation.
>
> System Operations – Improving the efficiency of the transportation network so that a larger share of vehicle operations occur in favorable conditions, with respect to speed and smoothness of traffic flow, resulting in more fuel efficient vehicle operations.

The *Moving Cooler* analysis estimates the effectiveness of strategies to reduce GHG emissions by reducing the amount of vehicle travel that occurs, by inducing people to use less fuel-intensive means of transportation (eg., walking, bicycling, transit, or carpooling), or by reducing the amount of fuel consumed during travel through transportation system improvements. Strategies are first assessed individually, and are then combined into "bundles" that illustrate the potential cumulative effects that could be achieved.

The effectiveness of each strategy in reducing GHG emissions is measured against a baseline developed by the authors of *Moving Cooler* that projects GHG emissions from the years 2010 to 2050. This baseline is based on an annual rate of vehicle and fuel technological change that indicates that emissions reductions from technology will largely be offset by increases in travel from a growing U.S. population.

The reductions in GHG emissions estimated to result from implementation of the *Moving Cooler* strategies are expressed as a percentage reduction from this baseline. TCAG used a conservative approach in estimating (**maximum 1.38% GHG reduction in 2042**) off-model GHG per capita reduction strategies as VMT reductions strategies have historically been challenging to implement in areas with relatively low levels of congestion.

TCAG included the following *Moving Cooler* Table 4.2 strategies that were quantified "off-model" using the **mid-range reduction method** between Expanded and Aggressive Implementation:

1. Active Transportation (Bicycle & Pedestrian)
2. Vanpool/Rideshare Employer-Based TDM Rule 9410
3. ITS/Ramp Metering/Signal Coordination/Incident Management
4. Electric Vehicle Penetration – Air District Incentive
5. Public Transportation (fares, transit expansion)

CARB Methodology to Adjust CO2 EMFAC Output for SB 375 Target Demonstrations

In addition, the 2018 RTP/SCS emissions modeling approach incorporates CARB's "Methodology to Calculate CO2 Adjustment to EMFAC 14 Output for SB 375 Target Demonstration." The emissions methodology assumes the same 2005 base year CO2 per capita estimate as for the 2014 RTP/SCS. That method used a prior travel model validated to the year 2010 observed data and backcast to 2005. The methodology then adjusts 2020 and 2035 target performance downward to account for fleet mix and emission factor updates between EMFAC2011 used for the 2014 RTP/SCS and EMFAC2014.

The EMFAC output post-processing worksheet calculates per capita CO2 reductions from 2005 base year for 2020, 2035, and RTP horizon year 2042 using CO2 emissions modeled with EMFAC2014 and the latest population projections for the region. The spreadsheet also incorporates the ARB CO2 Adjustment Methodology by applying the difference between CO2 per capita reductions modeled with EMFAC2011 and EMFAC2014 using 2014 RTP activity data to reductions achieved by the 2018 RTP/SCS using EMFAC2014.

Although this approach results in per capita CO2 reductions that are generally lower than otherwise modeled with EMFAC2014 alone **(Figure Methodology -12)**, ARB has indicated that this target demonstration approach is separate from the 2018 SB 375 target setting methodology and is not directly comparable to the target recommendations TCAG provided to ARB. **It is important to note that the CARB's CO2 per capita reduction adjustment does not include off-model reductions from Moving Cooler strategies.**

Figure Methodology -12

Performance Measure	Units	Preferred Scenario – Blueprint EMFAC 14	Preferred Scenario – Blueprint CARB EMFAC Adjust
Per Capita Greenhouse Gas Reduction CARB Targets 5% (2020) and -10% (2035)	Percentage Change CO2 Emissions (Auto & Light Truck) from 2005	2020: -13.1% 2035: -17.9% 2042: -18.6%	2020: -10.8% 2035: -13.8% 2042: -14.7%

2018 RTP/SCS Modeling Results

Figure Methodology -13
RTP/SCS Performance Results

Performance Measure	Units	Preferred Scenario - Blueprint	Alternative Scenario - Trend	Alternative Scenario - Blueprint Plus	Alternative Scenario - No Project
Per Capita Greenhouse Gas Reduction* * All scenarios meet -5% (2020) and -10% (2035) ARB Targets	Percentage Change CO2 Emissions (Auto & Light Truck) from 2005	2020: -13.1% 2035: -17.9% 2042: -18.6%	2020: -12.3% 2035: -16.0% 2042: -16.5%	2020: -13.3% 2035: -18.2% 2042: -18.9%	2020: -12.1% 2035: -16.1% 2042: -17.0%
Increased Urban Residential Density (25%)	2042 Gross Housing Units per Acre of New Development	6.1	4.9	6.4	4.9
Reduced Vehicle Miles Travelled (VMT)	2042 VMT per Weekday, All Vehicles and Purposes (x1000)	12,699	12,848	12,657	12,758
Reduced Criteria Air Emissions** ** All Scenarios Pass Conformity	2042 NOx Tons/Weekday	2.8917	2.9256	2.8821	2.9051
	2042 ROG Tons/Weekday	0.9866	0.9982	0.9834	0.9911
	2042 PM10 Tons/Weekday	0.7457	0.7544	0.7432	0.7492
	2042 PM2.5 Tons/Weekday	0.3030	0.3066	0.3020	0.3045
Reduced Commute Times	2042 Average Trip Time (Minutes)	16.31	16.26	16.32	16.45
Proximity of Housing to Jobs	2042 Average Trip Length (Miles)	11.06	11.00	11.05	10.91

Performance Measure (Continued)	Units	Preferred Scenario - Blueprint	Alternative Scenario - Trend	Alternative Scenario - Blueprint Plus	Alternative Scenario - No Project
Improved Reliability of the Road System	2042 Weekday Congested VMT (All Vehicle Classes, x1000)	2,001	2,043	1,971	3,796
Increased Use of Active Transportation Modes	2042 Mode Share Bike/Ped. (Percentage of All Trips)	1.15/6.10	1.13/5.68	1.15/6.20	1.12/5.57
Expanded Use of Transit	2042 Transit Ridership	25,345	21,384	25,410	16,042
Decreased Consumption of Land	Acres Consumed 2015-2042	8,884	10,525	8,487	10,525
Decreased Consumption of Important Farmland	Acres of Important Farmland Consumed Outside SOI 2015-2042	1,518	2,311	1,353	2,311
Reduced Impact on Environmental Resources (SJ Valley Green Print)	Acres of Critical Habitat Area Consumed for New Urban Growth 2015-2042	144	176	144	176
Reduced Impact on Environmental Resources (SJ Valley Green Print)	Acres of Present Vernal Pools Area Consumed for New Urban Growth 2015-2042	0	0	0	0

TCAG FINAL DRAFT 2018 RTP/SCS Base

2005	Persons/HU	Population	HU	EMP	Regional VMT	SB375 VMT	EMFAC 14 CO2	GHG/per capita lbs/day	Transit Ridership	TDM Mode Share DA	SR2	SR3+	Transit	Bike	Walk
Final VMIP2 Base Year	3.15	404,148	128,388	176,896	10,153,707	8,705,754	3,404	18.57	10,205	38.61%	26.32%	27.74%	0.75%	1.04%	5.55%

2017	Persons/HU	Population	HU	EMP	Regional VMT	SB375 VMT	EF 14 CO2	Transit Ridership	TDM Mode Share DA	SR2	SR3+	Transit	Bike	Walk
Final VMIP2 Base Year	3.17	471,842	148,898	176,289	10,547,370	9,153,694	3,586	16.75	13,515	38.19%	26.52%	27.73%	0.83%	1.08%	5.66%

TCAG FINAL DRAFT 2018 RTP/SCS Scenario Metrics

SB 375 Data

2018 ARB SB 375 Target methodology

	Persons/HU	Population	SF	MF	EMP	Regional VMT	SB375 VMT	EF 14 CO2 tons/day	GHG/per capita lbs/day	% GHG/per capita Reduction	% Moving Cooler Reduction	Total % GHG/per capita Reduction	Transit Ridership	TDM Mode Share DA	SR2	SR3+	Transit	Bike	Walk
2020																			
No Project Scenario	3.18	488,293	119,305	34,085	181,560	10,789,716	9,348,211	3,614	16.32	12.1%		12.1%	13,851	38.13%	26.56%	27.75%	0.83%	1.09%	5.65%
Old Plan Scenario Transit Grow	3.18	488,293	118,345	35,044	181,560	10,755,415	9,313,321	3,600	16.25	12.5%		12.5%	18,967	38.02%	26.46%	27.63%	1.11%	1.09%	5.69%
Trend Scenario Transit Maintain	3.18	488,293	119,305	34,085	181,560	10,780,895	9,339,393	3,610	16.30	12.2%	0.06%	12.3%	15,701	38.10%	26.53%	27.71%	0.93%	1.09%	5.65%
Blueprint Scenario Transit Grow	3.18	488,293	118,345	35,044	181,560	10,716,374	9,274,871	3,586	16.19	**12.8%**	0.33%	**13.1%**	19,621	37.78%	26.39%	27.58%	1.16%	1.10%	5.99%
Blueprint Plus Scenario Transit Grow	3.18	488,293	118,005	35,385	181,560	10,701,905	9,260,388	3,580	16.16	13.0%	0.33%	13.3%	19,654	37.73%	26.39%	27.57%	1.17%	1.10%	6.05%
2035																			
No Project Scenario	3.23	568,186	134,689	41,162	207,912	12,159,989	10,515,830	4,017	15.59	16.1%		16.1%	15,308	38.09%	26.68%	27.78%	0.79%	1.11%	5.55%
Old Plan Scenario Transit Grow	3.23	568,186	130,851	44,999	207,912	12,323,325	10,678,457	4,094	15.89	14.4%		14.4%	23,223	37.81%	26.61%	27.62%	1.17%	1.11%	5.68%
Trend Scenario Transit Maintain	3.23	568,186	134,689	41,162	207,912	12,201,803	10,557,662	4,038	15.67	15.6%	0.41%	16.0%	20,285	37.89%	26.61%	27.68%	1.04%	1.11%	5.67%
Blueprint Scenario Transit Grow	3.23	568,186	130,851	44,999	207,912	12,085,473	10,441,330	3,992	15.49	**16.6%**	1.34%	**17.9%**	24,143	37.52%	26.51%	27.54%	1.23%	1.13%	6.06%
Blueprint Plus Scenario Transit Grow	3.23	568,186	129,490	46,362	207,912	12,052,420	10,408,276	3,980	15.44	16.8%	1.33%	18.2%	24,223	37.44%	26.51%	27.51%	1.25%	1.13%	6.15%
2042																			
No Project Scenario	3.25	604,969	141,868	44,464	220,210	12,758,055	11,046,917	4,229	15.41	17.0%		17.0%	16,042	37.99%	26.74%	27.79%	0.79%	1.12%	5.57%
Old Plan Scenario Transit Grow	3.25	604,969	136,688	49,645	220,210	12,897,144	11,185,684	4,304	15.69	15.5%		15.5%	24,359	37.69%	26.67%	27.62%	1.16%	1.13%	5.72%
Trend Scenario Transit Maintain	3.25	604,969	141,868	44,464	220,210	12,848,274	11,137,389	4,275	15.58	16.1%	0.42%	16.5%	21,384	37.79%	26.67%	27.70%	1.03%	1.13%	5.68%
Blueprint Scenario Transit Grow	3.25	604,969	136,688	49,645	220,210	12,699,425	10,988,544	4,219	15.37	**17.2%**	1.38%	**18.6%**	25,345	37.39%	26.59%	27.54%	1.23%	1.15%	6.10%
Blueprint Plus Scenario Transit Grow	3.25	604,969	134,850	51,484	220,210	12,657,231	10,946,349	4,203	15.32	17.5%	1.38%	18.9%	25,410	37.31%	26.59%	27.51%	1.24%	1.15%	6.20%

TCAG FINAL DRAFT 2018 RTP/SCS

Criteria Pollutants EMFAC 14

	Summer ROG	Summer NOX	Winter NOX	Winter PM10	Winter PM2.5	Winter Heavy Duty Trucks PM10	Winter Heavy Duty Trucks PM2.5	Annual Heavy Duty Trucks PM10	Annual Heavy Duty Trucks PM2.5	Annual ROG	Annual CO	Annual NOX	Annual CO2	Annual PM10	Annual PM2.5	Annual SOx	Fuel Gas	Fuel DSL	Urban Gross Residential Density	Energy Use per Household
2005																				
Final VMIP2 Base Year	10.5225	28.6373	31.3572	1.4135	1.0033	0.7900	0.6208	0.7862	0.6208	9.3602	78.4561	30.2704	6511.7246	1.4096	0.9996	0.2303	478.7437	187.7021		
2017																				
Final VMIP2 Base Year	3.8978	9.9016	10.7708	0.7412	0.3546	0.1882	0.0656	0.1880	0.0656	3.3710	24.5587	10.4230	6109.0624	0.7410	0.3544	0.0603	437.3555	183.7527	4.3	178.4

TCAG FINAL DRAFT 2018 RTP/SCS Scenario Metrics

Criteria Pollutants EMFAC 14; ENVISION TOMORROW Metrics

	Summer ROG	Summer NOX	Winter NOX	Winter PM10	Winter PM2.5	Winter Heavy Duty Trucks PM10	Winter Heavy Duty Trucks PM2.5	Annual Heavy Duty Trucks PM10	Annual Heavy Duty Trucks PM2.5	Annual ROG	Annual CO	Annual NOX	Annual CO2	Annual PM10	Annual PM2.5	Annual SOx	Fuel Gas	Fuel DSL	Urban Gross Residential Density	New Developed Acres Consumed	Important Ag Land outside SOI Acres Consumed	Critical Habitat Land Acres Consumed	CO2 Emissions per Household	Water Consumption per Household	Energy Use per Household
2020																									
No Project Scenario	2.9319	7.6183	8.2453	0.7081	0.3169	0.1588	0.0317	0.1587	0.0317	2.5221	17.5664	8.0001	5802.7678	0.7080	0.3167	0.0572	400.7168	186.0886							177.4
Old Plan Scenario Transit Grow	2.9224	7.5940	8.2190	0.7058	0.3158	0.1583	0.0316	0.1582	0.0316	2.5140	17.5088	7.9746	5783.5497	0.7057	0.3157	0.0570	399.3609	185.4966							177.4
Trend Scenario Transit Maintain	2.9293	7.6120	8.2385	0.7075	0.3166	0.1587	0.0317	0.1585	0.0317	2.5199	17.5484	7.9935	5797.3411	0.7074	0.3165	0.0571	400.3161	185.9361							177.4
Blueprint Scenario Transit Grow	2.9119	7.5665	8.1893	0.7033	0.3147	0.1577	0.0315	0.1576	0.0315	2.5049	17.4424	7.9458	5763.4671	0.7032	0.3146	0.0568	398.0071	184.8239							177.4
Blueprint Plus Scenario Transit Grow	2.9079	7.5563	8.1782	0.7023	0.3143	0.1575	0.0315	0.1574	0.0315	2.5015	17.4179	7.9350	5755.4636	0.7022	0.3141	0.0567	397.4460	184.5743							176.0
2035																									
No Project Scenario	1.4015	3.0062	3.1963	0.7230	0.2965	0.1415	0.0060	0.1415	0.0060	1.1805	7.4608	3.1264	4566.9132	0.7230	0.2965	0.0447	276.2255	178.5688							166.3
Old Plan Scenario Transit Grow	1.4202	3.0466	3.2392	0.7327	0.3004	0.1434	0.0061	0.1434	0.0061	1.1963	7.5031	3.1683	4637.4492	0.7327	0.3004	0.0454	280.8883	180.9814							157.3
Trend Scenario Transit Maintain	1.4062	3.0165	3.2073	0.7255	0.2975	0.1420	0.0060	0.1420	0.0060	1.1845	7.4591	3.1371	4587.0835	0.7255	0.2975	0.0449	277.6381	179.1898							166.3
Blueprint Scenario Transit Grow	1.3928	2.9877	3.1767	0.7186	0.2946	0.1406	0.0059	0.1406	0.0059	1.1732	7.3855	3.1072	4543.1791	0.7186	0.2946	0.0445	274.9724	177.4815							157.3
Blueprint Plus Scenario Transit Grow	1.3890	2.9796	3.1680	0.7166	0.2938	0.1402	0.0059	0.1402	0.0059	1.1700	7.3646	3.0987	4531.1291	0.7166	0.2938	0.0444	274.2597	176.9965							155.4
2042																									
No Project Scenario	1.1747	2.7980	2.9630	0.7492	0.3045	0.1447	0.0060	0.1447	0.0060	0.9911	6.6040	2.9051	4572.9711	0.7492	0.3045	0.0447	272.9961	181.7117	4.9	10,525	2,310.6	176.0	14.8	293.0	158.9
Old Plan Scenario Transit Grow	1.1877	2.8285	2.9954	0.7573	0.3078	0.1463	0.0061	0.1462	0.0061	1.0022	6.6258	2.9368	4635.9355	0.7573	0.3078	0.0454	277.3375	183.7117	6.1	9,110	1,403.3	144.0	13.8	263.6	148.1
Trend Scenario Transit Maintain	1.1830	2.8177	2.9839	0.7545	0.3066	0.1457	0.0060	0.1457	0.0060	0.9982	6.6137	2.9256	4613.3388	0.7544	0.3066	0.0451	275.7609	183.0090	4.9	10,525	2,310.6	176.0	14.8	293.0	158.9
Blueprint Scenario Transit Grow	1.1694	2.7851	2.9494	0.7457	0.3031	0.1440	0.0060	0.1440	0.0060	0.9866	6.5352	2.8917	4560.9046	0.7457	0.3030	0.0446	272.6721	180.8901	6.1	8,884	1,518.3	144.0	13.8	264.0	148.3
Blueprint Plus Scenario Transit Grow	1.1655	2.7758	2.9395	0.7432	0.3020	0.1435	0.0060	0.1435	0.0060	0.9834	6.5123	2.8821	4545.8948	0.7432	0.3020	0.0445	271.7809	180.2894	6.4	8,487	1,353.3	144.0	13.5	255.4	145.1

TCAG FINAL DRAFT 2018 RTP/SCS Scenario Metrics

Item	Notes	Source
Persons/HU	Persons per housing unit	DOF
Population	Total scenario population	DOF
HU	Total scenario housing units	DOF
SF	Total single family housing units	DOF
MF	Total multi-family housing units	DOF
EMP	Total employment units	DOF
Regional VMT	Total daily VMT including XX trips	TCAG Model
SB 375 VMT	Total daily VMT excluding XX trips	TCAG Model
EF 14 CO2	SB375 daily CO2e metric tons (Annual) excluding XX trips	EMFAC 14
Moving Cooler Reduction	Percent CO2e per capita reductions from 2005 base	Moving Cooler Table 4.2
Total % GHG/per capita Reduction	Percent CO2e per capita reductions from 2005 base	EMFAC 14
Transit Ridership	Total daily regional transit ridership	TCAG Model
TDM Mode Share	Mode Share	TCAG Model
ROG	ROG total daily metric tons (Summer)	EMFAC 14
NOX	NOX total exhaust daily metric tons (Summer)	EMFAC 14
NOX	NOX total exhaust daily metric tons (Winter)	EMFAC 14
PM10	PM10 total daily metric tons (Winter)	EMFAC 14
PM2.5	PM2.5 total daily metric tons (Winter)	EMFAC 14
Heavy Duty PM10	PM10 total daily metric tons (Winter)	EMFAC 14
Heavy Duty PM2.5	PM2.5 total daily metric tons (Winter)	EMFAC 14
Heavy Duty PM10	PM10 total daily metric tons (Annual)	EMFAC 14
Heavy Duty PM2.5	PM2.5 total daily metric tons (Annual)	EMFAC 14
ROG	ROG total daily metric tons (Annual)	EMFAC 14
CO	CO total exhaust metric tons (Annual)	EMFAC 14
NOX	NOX total exhaust daily metric tons (Annual)	EMFAC 14
CO2	CO2e daily metric tons (Annual) including XX trips	EMFAC 14
PM10	PM10 total daily metric tons (Annual)	EMFAC 14
PM2.5	PM2.5 total daily metric tons (Annual)	EMFAC 14
SOx	SOx total exhaust metric tons (Annual)	EMFAC 14
Fuel Gas	Daily regional gasoline consumption thousands of gallons (Annual)	EMFAC 14
Fuel DSL	Daily regional diesel consumption thousands of gallons (Annual)	EMFAC 14
Urban Gross Residential Density	Gross residential density housing units per acre (Urban Areas)	Envision Tomorrow
New Developed Acres Consumed	New Developed Acres Consumed	Envision Tomorrow
Prime Ag Land Acres Consumed	Prime Ag Land Acres Consumed	Envision Tomorrow/FMMP
Critical Habitat Land Acres Consumed	Critical Habitat Land Acres Consumed	Envision Tomorrow/SJV Greenprint
CO2 Emissions per Household	CO2e metric tons per year	Envision Tomorrow
Water Consumption per Household	Water gallons per day	Envision Tomorrow
Energy Use per Household	Energy consumption in millions of BTU per year	Envision Tomorrow