TECHNICAL EVALUATION OF THE GREENHOUSE GAS EMISSION REDUCTION QUANTIFICATION FOR TAHOE METROPOLITAN PLANNING ORGANIZATION/ TAHOE REGIONAL PLANNING AGENCY'S SB 375 SUSTAINABLE COMMUNITIES STRATEGY

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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.

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EXECUTIVE SUMMARY

SB 375 (Steinberg, Chapter 728, Statutes of 2008), also known as the Sustainable Communities and Climate Protection Act, aims to reduce greenhouse gas (GHG) emissions from passenger vehicle travel through improved transportation and land use planning at the regional scale. It requires ARB to set GHG emission reduction targets for passenger vehicles for 2020 and 2035 for the State's federally-designated Metropolitan Planning Organizations (MPOs), including the Tahoe Metropolitan Planning Organization (TMPO) which represents the California portion of the Tahoe region.

SB 375 requires each MPO to explicitly consider the impact of land use patterns and transportation choices on GHG emissions by developing a Sustainable Communities Strategy (SCS) that meets ARB's targets. The SCS is incorporated into an MPO's Regional Transportation Plan (RTP) that is prepared every four or five years. ARB approved regional targets for each of the State's MPOs at its September 23, 2010, hearing. As they relate to the California portion of the Lake Tahoe region, the targets established by the Board call for a 7 percent reduction in per capita GHG emissions in 2020 and a 5 percent reduction in 2035 relative to 2005.

The Tahoe Metropolitan Planning Organization and the Tahoe Regional Planning Agency (TRPA) jointly released the Public Review Draft of their Regional Transportation Plan (RTP), also known as "Mobility 2035", on April 25, 2012. Mobility 2035 incorporates the region's SCS and contains integrated land use and transportation strategies for achieving the region's GHG emission reduction targets for 2020 and 2035.

On December 12, 2012, TMPO adopted the Public Review Draft RTP/SCS with minor modifications. On January 22, 2013, TMPO/TRPA submitted its SCS to ARB for review of its determination and appropriate action. The adopted SCS demonstrates that, if implemented, the California portion of the Tahoe region will achieve a 12.1 percent per capita GHG emission reduction in 2020, and a 7.2 percent reduction in 2035.

This report describes both the method ARB staff used to review TMPO/TRPA's SCS GHG quantification and the results of ARB staff's technical evaluation. The evaluation was conducted using ARB's methodology for review of GHG emission calculation procedures from SCS plans[1], tailoring the general methodology to address the unique characteristics of the Tahoe region.

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[1] Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375 (July 2011).

TAHOE REGION

Background

In California, Metropolitan Planning Organizations are responsible for preparing Regional Transportation Plans (RTPs). MPOs are also responsible for implementing the California Sustainable Communities and Climate Protection Act of 2008 (SB 375). This law requires preparation of a Sustainable Communities Strategy as part of the RTP to reduce regional GHG emissions from automobiles and light trucks for metropolitan regions within the State.

The Tahoe Metropolitan Planning Organization (TMPO) was created in 1999 by the Governors of California and Nevada, under federal authority (23 United States Code Section 134-135). TMPO is responsible for adopting the RTP for the Lake Tahoe region, and the SCS for the California portion of the region.

The Tahoe Regional Planning Agency (TRPA) is the land use planning agency responsible for approving the Tahoe Regional Plan Update. TRPA operates under the authority of the Bi-State Regional Planning Compact (Compact). Adopted in 1969, the Compact calls for a Regional Plan to establish a balance between the natural environment and the human-made environment. Goals and policies of the Regional Plan are intended to guide decision-making as it affects Tahoe's resources and environmental threshold standards.

Portions of California legislation, SB 575 (Steinberg)[2] and SB 375 address the linkage between land use and transportation planning for the California side of the Tahoe region, and thus the link between the RTP, including the SCS, and the Regional Plan Update. TMPO/TRPA's existing land use regulations and transportation programs contribute to attainment and maintenance of environmental threshold standards for the Tahoe region. The Tahoe Regional Plan Update focuses on expansion of transit services and accessibility through the design of residential development patterns, the walkability of communities, and the use of economic incentives and disincentives to promote achievement of air quality.

Regional Plan Update and the RTP/SCS

TRPA developed five land use forecast alternatives intending to encourage redevelopment and an effective transportation strategy that would help to mitigate adverse transportation conditions, facilitate attainment and maintenance of environmental threshold standards, and contribute to meet the per capita GHG targets associated with reduced vehicle miles traveled (VMT). Table 1 provides a list of the five land use alternatives.

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[2] SB 575 (Steinberg), Local planning: housing element (2009). See also http://www.leginfo.ca.gov/pub/09-10/bill/sen/sb_0551-0600/sb_575_bill_20091011_chaptered.html.

Table 1: Description of Land Use Alternatives

Alternatives	Description
1	No project, existing land use plan
2	Low development, increased regulation
3	Low development, highly incentivized redevelopment
4	Reduced development, incentivized redevelopment
5	Similar rate of development and regulatory structure of the 1987 Regional Plan

The alternative development patterns in TMPO/TRPA's analysis utilized the same regional projections, such as housing/ tourist accommodation units (TAU), employment, and population growth. Each alternative considers a mix of land use planning frameworks, the land use allocation system, environmental regulations and environmental incentives programs, and transportation strategies.

Preferred Alternative

TMPO/TRPA selected Alternative 3 (low development and highly incentivized redevelopment) as the preferred scenario. This alternative changes the existing land use designation for commercial/public services to mixed-use, and focuses on environmental redevelopment of the existing built environment, such as community centers that provide sidewalks, trails, and transit access, with a streamlined regulatory process. The current Plan Area Statements (PAS) and Community Plans (CP) land use planning system remain in place under this alternative, but also add three special planning districts categories: Town Centers, Regional Centers, and High Density Tourist Districts. TMPO/TRPA is proposing these new categories as areas targeted for redevelopment. Alternative 3 is built to accommodate an anticipated population increase in the California portion of the Tahoe region of approximately 5,900 new residents by 2035 and the construction of new Commercial Floor Area (CFA) and TAUs.

In addition to federal and state laws and regulation requirements, TMPO's RTP/SCS serves as the transportation plan element of TRPA's Regional Plan Update. The RTP/SCS contains three transportation strategies, designated A, B, and C. Each transportation strategy includes several subsets of transportation projects and is paired to one of the five land use alternatives considered in the Regional Plan Update process.

TMPO/TRPA coupled the Alternative 3 land use development scenario with the RTP's Transportation Strategy Package C, consisting of a variety of bicycle and pedestrian strategies, revitalization projects, the Lake Tahoe Waterborne Transit Project, and enhanced inter-regional transit operations. This combined alternative-strategy scenario provides for walkability and cycling within communities and more options for non-automotive transportation. Based on the Alternative 3 / Strategy C combination, GHG reductions of 12.1 percent by 2020 and 7.2 percent by 2035 are projected.

Tahoe's assumptions are consistent with guidance on developing SCS planning assumptions provided in the California Transportation Commission's (CTC) 2010 RTP Guidelines (see Appendix A for applicable guideline elements).

APPLICATION OF ARB STAFF REVIEW METHODOLOGY

In July 2011, ARB staff released to the public a methodology that details how ARB will evaluate MPO SCSs in order to fulfill its statutory responsibility under SB 375, which is to accept or reject the MPOs' determination that the SCS would, if implemented, meet the targets.

The review of TMPO/TRPA's SCS focused on the technical aspects of regional modeling that underlie the quantification of GHG reductions. This review examines TMPO/TRPA's model inputs and assumptions, modeling tools, application of the model, and modeling results.[3]

ARB staff tailored the general methodology to be applicable for TMPO/TRPA's SCS to address the unique characteristics of the Tahoe region and transportation modeling approach. ARB staff evaluated how TMPO/TRPA's models operate and perform in estimating travel demand, and how well they provide for quantification of GHG emissions reductions associated with the SCS. In evaluating TMPO/TRPA's model sensitivity, ARB staff examined how well TMPO/TRPA's travel demand model replicated observed results and whether the application of the post processing tool was appropriate and achieved reasonable results.

ARB staff's evaluation used publicly available information in TMPO/TRPA's RTP/SCS, including RTP technical appendices, and the model description and validation reports. In order to assess technical soundness and general accuracy of TMPO/TRPA's GHG quantification, three central components of TMPO/TRPA's GHG analyses were evaluated: data inputs and assumptions, modeling tools, and performance indicators.

Data Inputs and Assumptions

ARB staff evaluated TMPO/TRPA's key model inputs with underlying data sources and assumptions to confirm they represent current and reliable data for use in their model.

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[3] The review was based on the general method described 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." http://www.arb.ca.gov/cc/sb375/scs_review_methodology.pdf

This involved using publicly available, authoritative sources of information, such as national and statewide survey data on socio-economic and travel factors. Relevant model inputs for GHG quantification that ARB staff reviewed included: 1) regional socio-economic characteristics, 2) the region's transportation network, and 3) travel inputs. Pertinent documentation of region-specific forecasting processes and approaches were also evaluated.

Modeling Tools

TMPO/TRPA's modeling documentation reports were reviewed to assess how well their travel demand model replicates observed results based on both the latest socioeconomic, and travel data inputs and assumptions used to model the SCS. TMPO/TRPA's post processor documentation and results were also reviewed to assess whether an appropriate methodology was used to quantify the expected reduction in GHG emissions. In addition, TMPO/TRPA's modeling practices were reviewed for consistency with the CTC's "2010 California Regional Transportation Plan Guidelines," the Federal Highway Administration's (FHWA) "Model Validation and Reasonableness Checking Manual," and other key modeling guidance and reference documents (see Appendix A for more detailed information).

Performance Indicators

Performance indicators are used to test the model for sensitivity to changes in VMT, whether through changes in travel modes, vehicle trip distances, or land use. TMPO/TRPA developed two performance indicators -- residential density and passenger VMT -- to evaluate the effect of implementing the RTP/SCS. ARB staff performed a qualitative evaluation of these individual indicators to determine if increases or decreases are directionally consistent with TMPO/TRPA's modeled GHG emissions reductions.

DATA INPUTS AND ASSUMPTIONS

TMPO/TRPA's RTP/SCS modeling approach is based upon a number of inputs and assumptions which influence the effectiveness of the GHG emission reduction strategies. Inputs and assumptions are entered into the model to characterize existing and future land use, socio-economic data, and transportation network characteristics. ARB staff evaluated the appropriateness of the data that were used and the model's response to changes in these inputs and assumptions.

Demographics and the Regional Growth Forecast

Demographic inputs and assumptions describe the number and key characteristics of the population expected to be living, working, and travelling in a region. To estimate the effects on GHG emissions for the region, ARB staff reviewed each of these inputs.

Table 2 summarizes TMPO/TRPA's estimate of population, employment and housing for the region and the California portion of the region for 2005, 2010, 2020, and 2035.

Table 2: Tahoe's Growth Forecast

Year	Population		Employment		Housing Units	
	California[1]	Region[2]	California[1]	Region[2]	California[1]	Region[2]
2005	41,213	55,232	11,185	22,874	33,835	46,350
2010	41,176	54,473	11,354	22,605	35,260	47,392
2020	43,934	58,049	12,034	23,143	37,809	50,412
2035	45,468	60,365	12,854	23,804	38,921	51,552

[1] Describes the California portion of the Tahoe Region
[2] Describes the whole Tahoe Region (California and Nevada)

Tahoe's growth forecast is based on the 2010 U.S. Census. TMPO/TRPA used Census tract level data from eastern El Dorado County and from eastern Placer County to estimate the population of the California portion of the Tahoe region for 2010. ARB staff compared Department of Finance's (DOF) 2010 projections for El Dorado County and Placer County to the 2010 Census tracts, and confirmed that both data sets are consistent (estimates < 1%). TMPO/TRPA's growth forecast for future year projections is guided by the Regional Plan and implementing ordinances.

Tahoe's 1987 Regional Plan focused on growth control and on regulating development practices that degrade the natural and built environments. These growth control and environmental best practices are implemented through a development allocation system, environmental threshold carrying capacities, and land use ordinances. TMPO/TRPA updated its 1987 Regional Plan in conjunction with the 2012 RTP/SCS focusing on environmental redevelopment that will replace older, environmentally degrading developments with more sustainable development and restored landscapes.

The Regional Plan Update allocates to communities region wide development rights for new residential and tourist accommodation units, and commercial floor area over a 20-year planning horizon. New residential units may be allocated on remaining developable parcels in each jurisdiction. Additionally, TMPO/TRPA dedicates 600 new bonus units to multi-family, affordable, or moderate-income housing over the life of the plan, plus 874 bonus units that remain available from the 1987 Regional Plan. Bonus units may be used to incentivize transfers of development rights and existing development to enhance higher density town centers and away from sensitive parcels and parcels far from town centers. Residential densities in town centers could reach up to 25 units per acre. An additional 342 tourist accommodation units and 583,600 square feet of commercial floor area have also been allocated, almost all of which will be built in town centers.

Housing

The RTP/SCS assumes housing allocations from the Regional Plan Update under the preferred alternative for 2020 and 2035. For purposes of its analysis, TMPO/TRPA distributed bonus units to qualifying jurisdictions in areas designated as town centers. To allocate these units, TMPO/TRPA first calculated and classified the number of dwelling units by traffic analysis zones (TAZ) and by the U.S. Census designation of whether it is a year round residential or a secondary (vacation home) unit. It then calculated year round population and second-homeowner population. Finally, the income stratification of the dwelling units was classified and U.S. Census designation of persons per household by TAZ was used.

California jurisdictions must adopt housing element updates that demonstrate accommodation of an eight-year projection of housing need, known as the Regional Housing Needs Assessment (RHNA). In consultation with TMPO, the Sacramento Area Council of Governments (SACOG) projects the housing need for the California side of the Tahoe region.

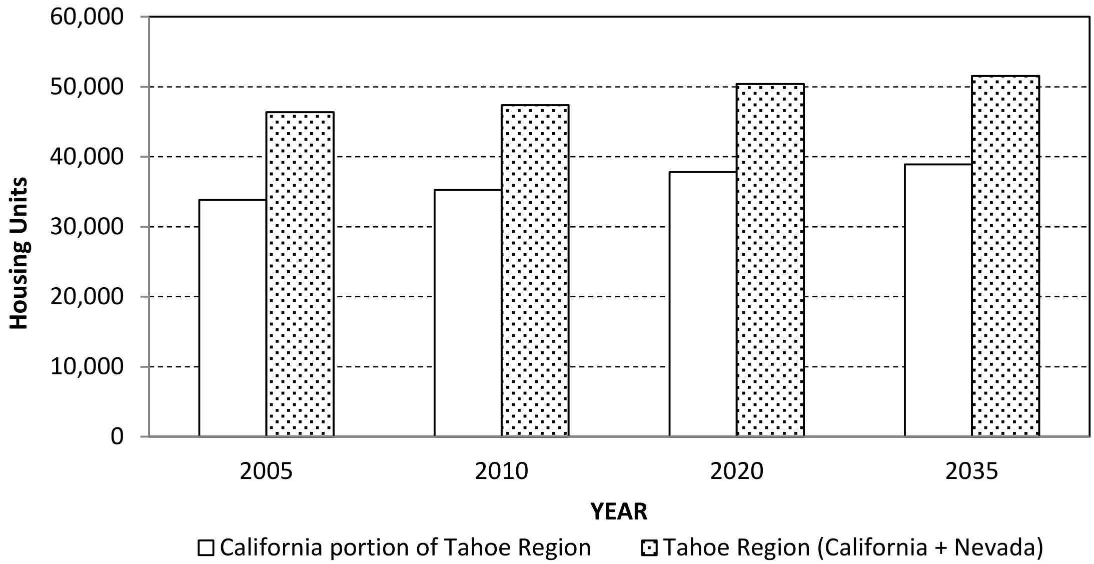
As a result, in December 2011, SACOG approved the new RHNA projections for 2013-2021 for the California portion of the Tahoe basin. The regional housing needs for Tahoe's California jurisdictions as well as the proposed SCS allocations are shown in Table 3.

Table 3: Allocation of New Housing by California Jurisdiction, 2013-2021

Jurisdiction	Total Housing Units RHNA Requirement	Total Housing Units Lake Tahoe SCS allocation
Placer County (Tahoe portion)	328	562
El Dorado County (Tahoe portion)	480	654
City of South Lake Tahoe	336	605
Total	**1,144**	**1,821**

Consistent with SB375 requirements, TMPO/TRPA's SCS provides sufficient housing to meet the total housing allocation. Since RHNA calls for MPOs to perform an eight-year projection, TMPO/TRPA converted the proposed SCS allocation to match the same eight-year time frame. Currently, the Tahoe region contains approximately 47,000 housing units, of which about 35,000 are located on the California side and 12,000 on the Nevada side. The largest number of housing units is single-family homes on medium-sized lots. The SCS assumes an increase in housing supply over time with additional multi-family housing in town centers.

Figure 1: Housing Unit Projection

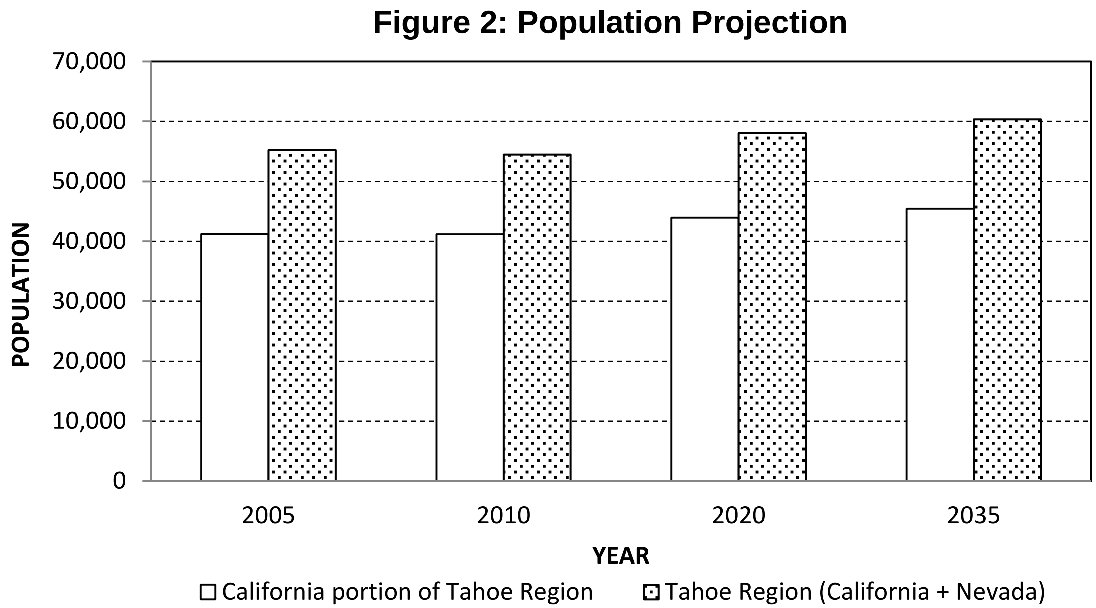


The Tahoe region is projected to add nearly 150 housing units per year between 2010 and 2035, or approximately 3,700 units total. The housing unit ratio between California and Nevada of 3-to-1 is expected to continue proportionally throughout 2035 (Figure 1). Between 2010 and 2020, TMPO/TRPA projects the California side will add approximately 2,500 housing units, and between 2020 and 2035 approximately 1,100 units.

Population

Population growth in the Tahoe region is constrained by limits on land use and environmental threshold carrying capacities defined in the Regional Plan. The 1987 Regional Plan provided for moderate growth and set initial limits by allocating the amount of residential, commercial, and tourist-related development. TMPO/TRPA uses the growth allocation system described above to distribute the forecast population.

The permanent residency forecast indicates that the California population of Tahoe is expected to grow by approximately 2,800 people between 2010 and 2020, and approximately 4,300 people between 2010 and 2035. U.S. Census population data for 2005 and 2010 shows the same ratio of 3-to-1 between California and Nevada continuing throughout the projection years 2020 and 2035 (Figure 2).



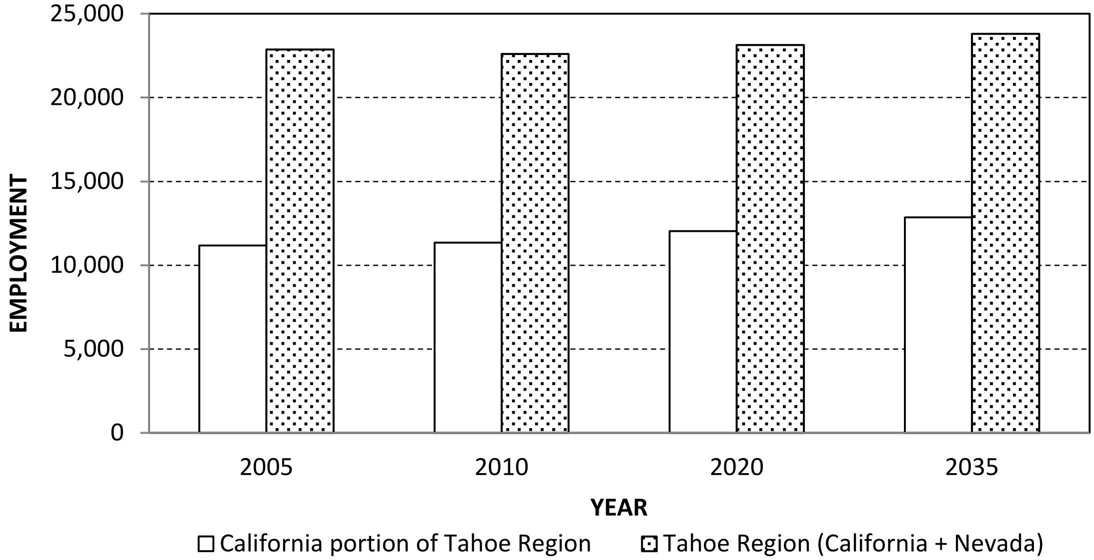
Between the forecast year and 2010, the baseline population remained steady, due in part to a declining regional economy and a dramatic increase in residential home prices starting in 2001.

Employment

Employment opportunities are projected based on the amount of available commercial floor area for 2005, 2010, 2020, and 2035. The floor area is allocated by local jurisdiction and calculated using Institute of Transportation Engineers (ITE) rates based on the ratio of employee-to-floor area. Tahoe's growth forecast anticipates approximately 540 new employees between 2010 and 2020, and approximately 1,200 new employees between 2010 and 2035 (Figure 3).

As a result of the recent recession there was a reduced rate of economic growth in the region since recreation, entertainment, and service industries are critical to the region's economic base.

Figure 3: Employment Forecast



While the regional population is split 3-to-1 California to Nevada, the employment split is almost even. This imbalance ratio has resulted in California permanent residents in the region commuting longer distances to regional employment centers. Statistics on seasonal residents suggest a similar imbalance.

The growth forecasts used in the SCS modeling analysis for housing, population, and employment used reasonable methodology. TMPO/TRPA relied on appropriate federal and state sources, such as the U.S. Census (2000 and 2010), household travel surveys, and growth projections. TMPO/TRPA also convened a local expert panel[4] to evaluate its growth forecast process. Tahoe's forecasting methods are consistent with those used by the U.S. Census Bureau and the California Department of Finance (DOF).

Current and Future Land Use Development Patterns

As part of the RTP development process, TMPO creates long-range land use forecasts that estimate the amount, type, and location of development. These development patterns account for Tahoe's population of seasonal and permanent residents and visitors, and include employment, households, and tourist accommodation units. This anticipated future growth pattern is the basis from which TMPO/TRPA plans for transportation system improvements that are needed to serve the region's future population and economic growth.

[4] Peer review panel included experts from the California Department of Transportation (Caltrans), local city planners and consultants.

Current Land Use

Approximately 12 percent or 24,000 acres out of a total of 201,500 acres, of the Tahoe land area has been developed for commercial, tourist accommodation, and residential uses (see Table 4). The majority of developed land is zoned for residential uses and is comprised primarily of detached single family residences. The permanent resident population is approximately 55,000, down from its peak of 63,000 in 2000. Commercial and tourist related land uses make up a smaller portion of the developed area and are found along the major transportation routes US 50, SR 28, and SR 89. Many of the commercial structures and establishments were built during the 1950s and 1960s and are characterized by strip development land use patterns.

There are approximately 47,400 residential units within the Tahoe region, including 2,034 units built within the last 10 years. Approximately 4,700 parcels are currently vacant in the region, primarily within residentially zoned lands. Tahoe's current land use pattern is illustrated in Figure 4.

Tahoe's development patterns are limited by environmental restrictions[5] on land uses and a marketable rights[6] transfer program, which constrains the amount of residential, commercial, and tourist development allowed in the region.

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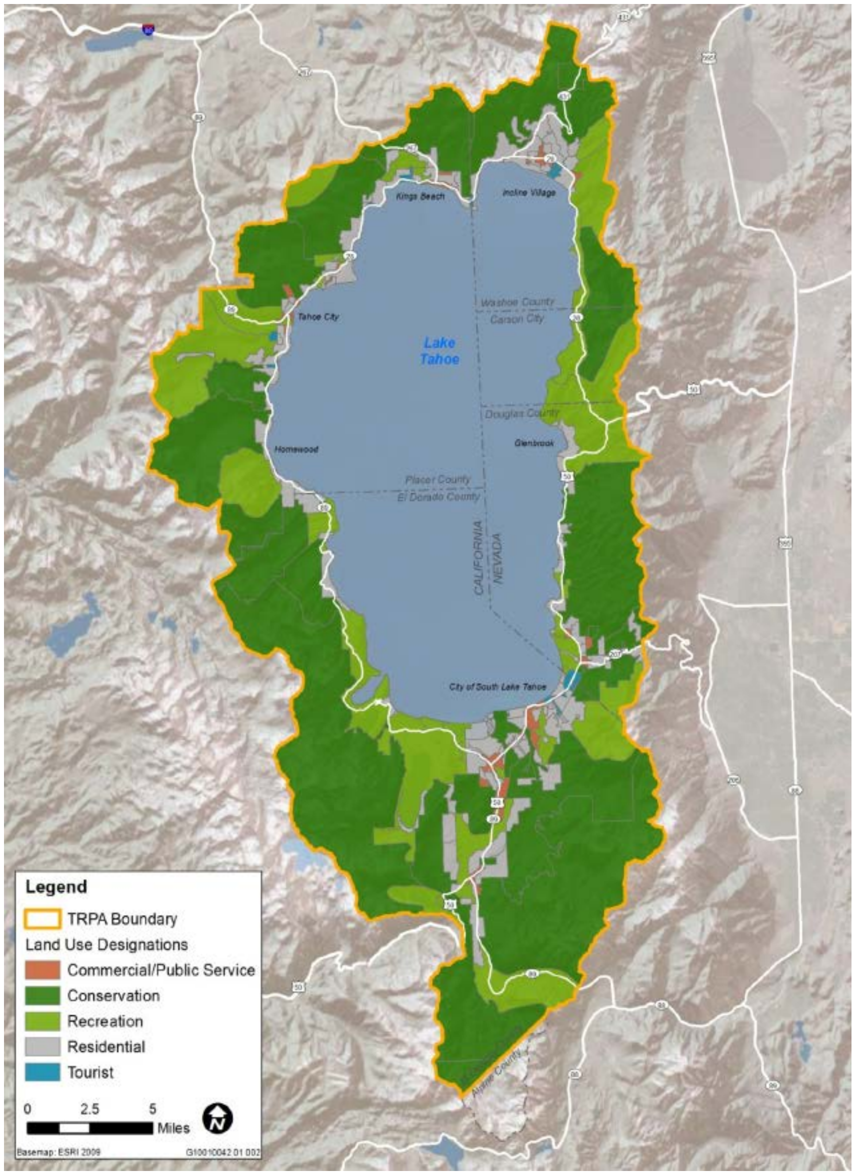
[5] TRPA Authority

[6] The Marketable Rights Transfer program promotes environmentally sensitive development by directing development to the most suitable areas, managing growth in a manner consistent with progress toward meeting environmental threshold standards, encouraging consolidation of development through transfer of development rights, allocations, and coverage, and conditioning approvals of projects on improved off-site erosion run-off control and air quality.

Figure 4: Tahoe's Land Use Pattern



Forecast Process

Land in the Tahoe region is assigned to one of five classifications: Conservation, Recreation, Residential, Commercial and Public Service, and Tourist. These classifications, summarized in Table 4, are further supplemented by PASs that provide a detailed planning guide within discrete areas of the region, including CP areas or areas targeted for scenic restoration, and affordable housing. PASs provide special planning considerations for specific areas, including policies, maximum densities for residential and tourist accommodation uses, community noise equivalent levels, allowable and special uses, and the permissible amount of additional recreation capacity.

Table 4: Land Use Classification

Land Use Classification	Acreage	Percentage
Conservation	132,326	65.7
Recreation	45,208	22.4
Residential	20,651	10.3
Commercial and Public Service	2,314	1.1
Tourist	967	0.48
Total	**201,466**	**100**

Transportation Network Inputs and Assumptions

The transportation network for the Tahoe region includes regional roadways and local streets, bus systems, water transit, rail lines, airports, sidewalks, and bike paths. TMPO/TRPA used an Activity-Based Travel Demand Model (ABM) to model the region's highway and transit networks, link capacity, and free-flow speed assumptions. Because the ABM was designed for modeling travel demand for the entire Tahoe region rather than just the California portion, model inputs discussed in this report are specified as either region-wide or California-specific.

Street Network

The Tahoe region's street network is a representation of the automobile roadway system, whose functional classification system includes principle arterial, minor arterial, collector, and centroid connector[7]. In the traffic assignment step of the ABM, the street network provides the basis of estimating zone-to-zone travel times and costs for each time period: AM Peak (AM), Midday (MD), PM Peak (PM) and Late Night (LN). Based on the 2006 and 2010 Travel Mode Share Surveys conducted by TMPO/TRPA, about one percent of the total number of trips is generated from the transit mode. Therefore, only the trips generated from the drive-alone and shared auto modes are assigned to the street network. Table 5 summarizes the reported Lake Tahoe region street lane miles in 2010 by functional class.

Table 5: Lake Tahoe Region Base Year Lane Miles by Functional Class

Functional Class	Lane Miles (2010)
Arterials	110
Collectors	155
Local street	464

[7] Centroid connectors are abstract links in the model, intended to represent local street access to the collector-and-above roadway network.

ARB staff compared the methodology TMPO/TRPA used in the street network development with the NCHRP Report 365[8]. TMPO/TRPA followed acceptable practice, and their methodology is consistent with the NCHRP 365 report. In addition, the functional classification definitions used in the street network are consistent with FHWA's Federal Functional Highway Classification system.

Street Capacity

Street capacity is defined as the number of vehicles that can pass a certain point of the street at free-flow speed in an hour. The travel demand model used street capacity as an input for estimating congestion.

The TMPO/TRPA ABM categorizes regional street capacities by functional class expressed in hourly capacity of vehicles-per-lane-per-hour (vplph), as summarized in Table 6**.**

Table 6: Reported Lake Tahoe Region Roadway Capacity

Functional Class	Street Capacity (vplph)	Base Multilane Highway Capacity[9] based on Free Flow Speed (vplph)
Principle arterial	1100	2200
Minor arterial	800	2100
Collectors	500	2000

TMPO/TRPA's assumptions used in the street network of their ABM are reasonable because the reported street capacities are within the FHWA's estimates of base multilane highway capacity based on free flow speed (FFS).

Free-Flow Speed

Travel demand models use free-flow speed to calculate the shortest travel time between the origin and the destination of a trip assigned to the street network. Factors that can affect the actual travel speed include the prevailing traffic volume on a link, posted speed limits, adjacent land use activity, functional classification of a street, type of intersection control, and spacing of intersection controls. The TMPO/TRPA ABM defines free-flow speeds by posted speed limits. The reported speed limits in the region are listed by area type in Table 7.

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[8] The NCHRP Report 365 describes travel demand modeling theory and techniques, and their common applications by transportation planning agencies, and observed data for key modeling parameters at the national level.

[9] Base Capacity = 1,000+20*FFS; for Free Flow Speed (FFS) less than or equal to 60 mph.

Table 7: Tahoe Region Free-Flow Speed by Area Type

Area Type	Speed Limit (mph)
Rural	60
Suburban	55
Urban	50

The methodology TMPO/TRPA used in the estimation of free-flow speed based on the posted speed is consistent with the recommended practice indicated in the NCHRP Report 365.

Transit Network

The transit network in the ABM is used to calculate transit path travel time and cost between route stops in the system on the underlying street network, perform transit assignments, and measure accessibility. Transit services in the TMPO/TRPA area include bus, rail, and ferry for residents, workers, and visitors.

On-road transit service in the Tahoe region is currently limited to bus transit. Therefore, the ABM's modeled transit network was based on information from the local bus routes, bus stops information, and the underlying street network. TMPO/TRPA reported, in 2010, the region's daily bus transit operation miles were 3,640 miles, and the daily total transit vehicle service was 409 hours.

The ABM identifies the transit routes or paths in the network that have the least time and cost for the traveler by determining the shortest path between zones. The model estimates these "skims" separately for walk-to-transit and drive-to-transit modes. For the walk-to-transit mode, the model assumes a person walks from his/her origin zone to the closest bus stop; for drive-to-transit mode, the model assumes a person accesses transit by driving to a bus stop, often using a park-and-ride lot. The model also assumes that access from the bus stop to the destination zone is always made by walking.

TMPO/TRPA followed acceptable practice for modeling the transit network, and the region's methodology is consistent with the procedures discussed in the "NCHRP Report 365" and the USDOT-FHWA Manual.

Non-Motorized Transportation Facility

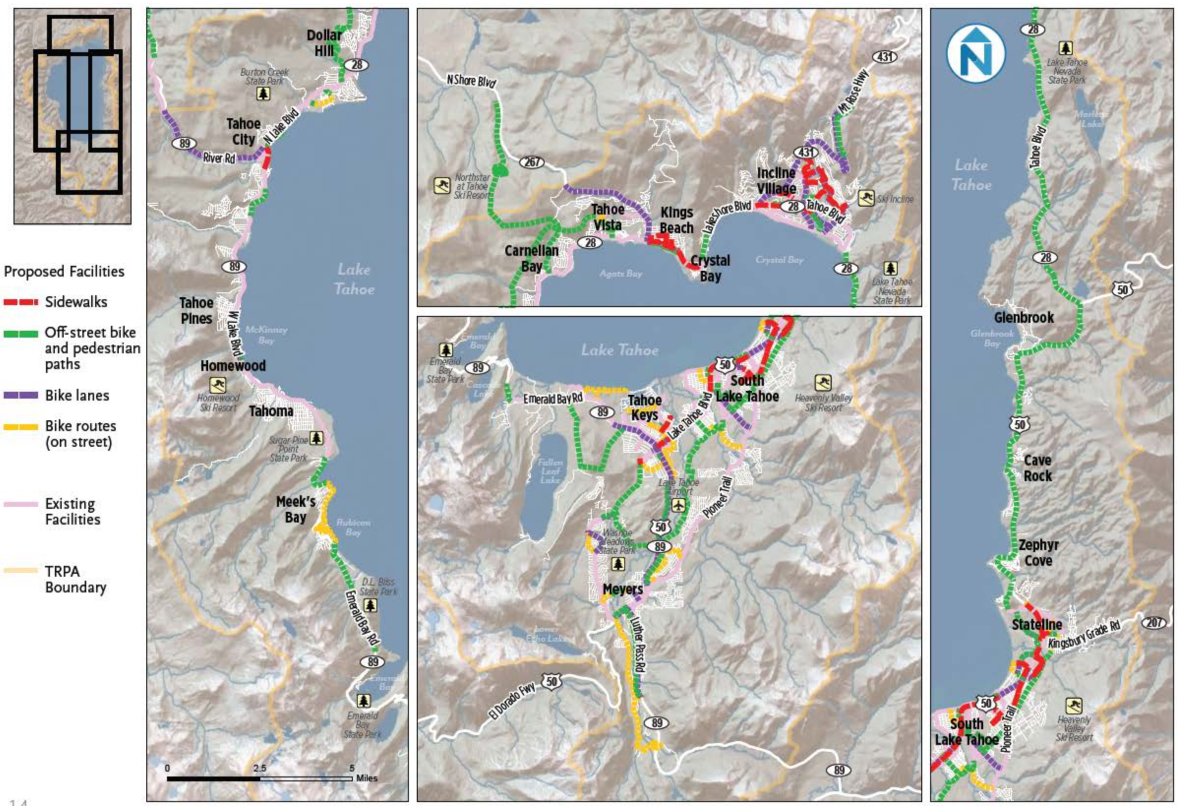
For non-motorized mode trips, the ABM assumes a walk speed of 3 miles per hour in estimating the travel cost and time associated with walking. Table 8 presents the base year (2010) non-motorized facility lane miles assumed by the model.

Table 8: California-Specific Non-motorized Facility Lane Miles

Non-Motorized Functional Class	California-specific Lane Miles (2010)
Bike path[10]	31
Bike lane[11]	17

Figure 5 presents the existing and proposed non-motorized transportation facility coverage in the Tahoe region. The definitions of bike path and bike lane are consistent with those given in the "Highway Design Manual" by Caltrans.

Figure 5: Existing and Proposed Bicycle and Pedestrian Facilities



10 Bike paths provide a completely separated right of way for the exclusive use of bicycles and pedestrians, with cross-flow by motorists minimized.

11 Bike lanes provide a lane for one-way bike travel on a street or highway, which is separated from autos with road striping.

Travel Demand Inputs and Assumptions

Assumptions related to the number of vehicle trips and trip lengths influence a travel demand model's prediction of the amount of travel occurring in a region. ARB staff reviewed the inputs and assumptions used in the TMPO/TRPA model related to factors that influence the amount of regional travel and travel modes. Specifically, ARB staff compared vehicle trip rate and trip length inputs to independent data sources.

Trip Generation Rates

Vehicle trip factors are used in a transportation model to gauge what influences the amount of travel in a region and why the travel is generated. These factors include automobile ownership, income, household size, density and type of employment, the availability of public transportation, and the quality of the transportation system. Trip generation inputs to the model are used to reflect the average daily person trips for each trip type in the Tahoe region.

TMPO/TRPA estimates trip generation rates based on data from the 2000 TMPO/TRPA Household Survey. The model then estimates trips as "activity tours." A tour represents all of the daily activities and travel a person conducts between leaving and returning home, including trips for work, school, shopping, and recreation. The ABM groups tours into either mandatory or non-mandatory tours. Mandatory tours include home-based work or home-based school trips. Non-mandatory tours include all other types of tour purposes, for example, social or recreational trips.

Trip Length Distribution

In the traffic assignment step of the travel demand model, trip lengths are estimated using the street network and are used as inputs to calculate zone-to-zone travel impedances. To check the reasonableness of trip length inputs, TMPO/TRPA compared base year modal trip length data to the 2009 NHTS data.

Table 9 summarizes the average reported trip length inputs and the comparison to the 2009 NHTS data.

Table 9: Region Average Reported Trip Length by Mode

Mode	Average Trip Length (miles)	
	TMPO/TRPA (2010)	NHTS (2009)
Auto	18.69	12.09
Walk	1.8	0.98
Bike	2.4	N/A

TMPO/TRPA's trip length for auto trips and walk trips are, on average, greater than what is reported for the nation as a whole. The greater distance in auto trips may arise from the unique commute pattern of the bi-state nature of the Tahoe Region;

commuters who reside on the California side of the region could drive to the Nevada side for employment at the casinos.

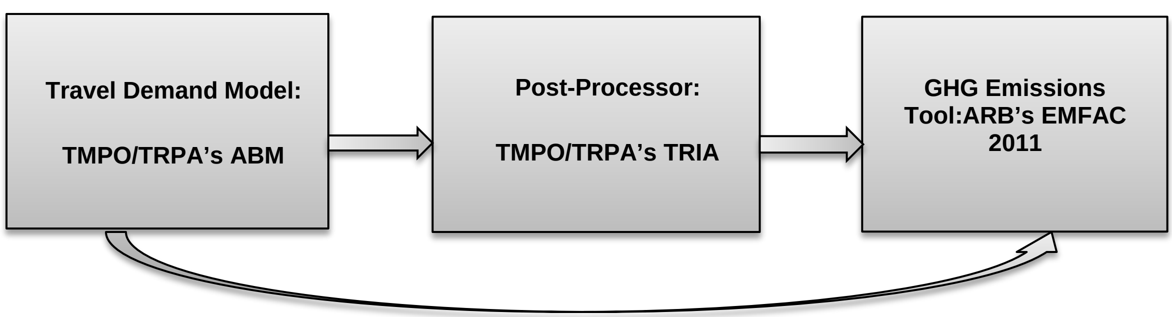
MODELING TOOLS

ARB staff used its evaluation methodology to review TMPO/TRPA's use of modeling tools to quantify GHG emissions in the SCS.

TMPO/TRPA utilizes three modeling tools to quantify GHG emissions that would result from the implementation of their RTP/SCS (Figure 6): the TMPO/TRPA Activity-Based Travel Demand Model, the Trip Reduction Impact Analysis Tool (TRIA), and ARB's vehicle emission model EMFAC 2011.

TMPO/TRPA used the ABM to estimate regional travel demand based on modeling inputs such as base year population, employment, and planning assumptions about future year land use, housing, and the transportation network. The main outputs of this travel demand model are VMT, vehicle hours traveled (VHT), number of vehicle trips, and average speed.

Figure 6: TMPO/TRPA's Modeling Tools

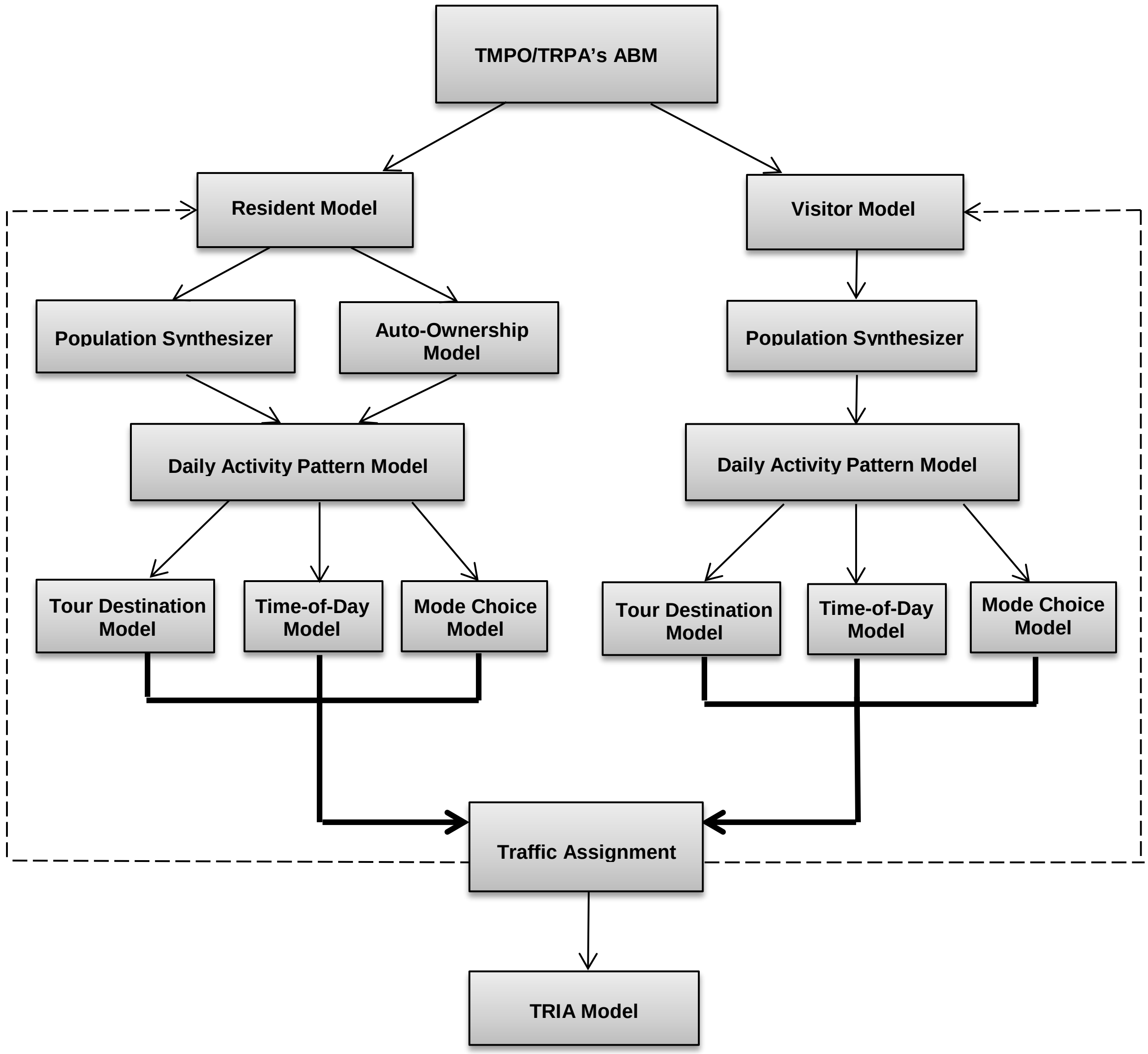


To estimate the percent reduction in vehicle trips from implementation of its RTP/SCS for 2020 and 2035, VMT and number of vehicle trips from the travel demand model is input into the post-processor, the TRIA model. VMT and speed outputs from the post-processor and the travel demand model is then converted to CO_2 emissions using EMFAC 2011.

Activity-Based Travel Demand Model

TMPO/TRPA developed an input file for the travel demand model that includes zonal level geographic, demographic, and socio-economic data for the region. Zonal variables in the socio-economic file include characteristics that help drive transportation and housing choices, e.g., an attractiveness index, urban type, accessibility index, employed residents, socio-economic characteristics, visitor capacity, and occupancy rates.

Figure 7: Structure of the Activity-Based Travel Demand Model



The structure of the travel demand model is based on the concept of an activity-based model originally developed for Columbus, Ohio. TMPO/TRPA's ABM components consist of an activity-based resident model and an activity-based visitor model (Figure 7) that use a population synthesizer and auto ownership model; a daily activity pattern model to choose a full day activity pattern for each person in the region; and aggregate trips generated from both the resident and visitor models. Trips are then assigned to the street network. TMPO/TRPA performed ten runs of the ABM and analyzed the convergence of the traffic assignment results. TMPO/TRPA then used the results of the three surveys that were conducted in 2006 to calibrate the ABM: the Tahoe Resident Survey, Overnight Visitor Survey, and Second Home Owner Survey.

Population Synthesizer

TMPO/TRPA also used the information from the socio-economic file as inputs to the population synthesizer to create a synthetic population that matches household level and person level characteristics in the region. The specific zonal characteristics that TMPO/TRPA considered are the average number of workers in a household per zone, average household size, and number of households per income group.

To develop the synthetic population, TMPO/TRPA set up a 3-dimensional table for each zone: number of households by size, number of workers, and income. TMPO/TRPA also used the Public Use Micro-Sample Area (PUMA) to obtain household records. The synthesizer then randomly drew zones in the region to match the given category until all of the households were assigned.

Auto-Ownership Model

TMPO/TRPA created the auto-ownership model to estimate the availability of automobiles per household in the region. The five types of auto-ownership assumed in this model are: no autos, one auto, two autos, three autos, and four or more autos. The availability of autos for a household was used as a key parameter in the auto-ownership model.

For validation, TMPO/TRPA matched the auto-ownership model outputs to observations from the 1,220 surveyed households in the region. It then applied expansion factors to represent the entire population of 22,361 households from the Census Transportation Planning Package 2000 (CTPP 2000).

Table 10: Modeled Household Auto-Ownership and Census Results

Auto(s) Owned	CTPP 2000	Model Results
0	1,462	1,232
1	5,937	6,170
2	9,067	8,608
3	4,166	4,187
4+	1,729	2,164
Total	22,361	22,361

Table 10 compares modeled household auto-ownership results to observations based on the Census Transportation Planning Package 2000 (CTPP 2000).

Daily Activity Pattern Model

The Daily Activity Pattern (DAP) Model simulates a full day activity, travel schedule, and mode choice for each person from the modeled synthetic population in the region. The DAP model consists of three sub-models or components: a tour destination, time-of-day, and mode choice.

The three main pattern categories in the DAP model are: mandatory pattern for work or school, non-mandatory pattern for maintenance and discretionary tours, and at-home pattern for accounting only in-home activities. Parameters considered in the DAP model include age, ability to drive, and employment. Also, the DAP model captured most intra-household interaction in their daily activities. TMPO/TRPA validated model results with the observed daily activity patterns from household surveys.

Tour Destination

The first component of the DAP model is the tour destination model, which is used to determine where a tour will go. The destination model is a multinomial logit model that treats each potential destination zone as an alternative. Modeling parameters considered in the destination model include travel distance, income level, area type, attractiveness of a zone, and accessibility.

The destination model has four sub-models to account for different tour purposes and residential status: mandatory tour destination, joint tour destination, non-mandatory tour destination, and visitor tour destination. As a calibration process of the destination model, TMPO/TRPA compared model results of county to county flows, tour distance, and internal to external flows with the observed data from the household travel survey.

Table 11 summarizes the comparison between modeled travel distance and time and observed values from the household travel survey for the mandatory tours.

Table 11: Modeled and Observed Travel Distance and Travel Time

Trip Type	Travel Distance		Travel Time	
	Household Travel Survey	Model Result	Household Travel Survey	Model Result
Mandatory Work Trips	4.1 to 4.6	4.2 to 4.6	7.9 to 8.7	7.9 to 8.6
Mandatory School Trips	2.8 to 3.6	2.7 to 4.2	5.6 to 7.1	5.4 to 7.6

Time-of-Day

The second component of the DAP model is the time-of-day model (TOD model). The TOD model is a multinomial logit model for estimating the start and stop hour pairs for each of the alternative daily activity patterns. TMPO/TRPA calibrated the estimates of start time, end time, and duration of the tour from the TOD model with observations from the household travel survey.

Mode Choice

The third component of the DAP model is the mode choice model. The mode choice model is also a multinomial logit model. Given a tour purpose, each available mode of transportation is considered as an alternative mode choice. For example, for the mandatory tours, there are six available modes: drive-alone; shared auto; walk to transit; drive to transit; non-motorized; and school bus.

The mode choice model compares across alternatives based on travel time. For an alternative that is associated with a cost, such as bus fare for taking transit or the vehicle operating cost for driving, the cost is converted into a time factor. TMPO/TRPA calibrated the mode choice model with data from its household travel survey (Table 12).

The method used in developing the mode choice model is consistent with the approach used nationwide as cited in the National Cooperative Highway Research Program (NCHRP) Report 535.

Table 12: Range of Percent of Mode Share for Mandatory Tours

Mode	Model Result	Survey Result
Drive Alone	68 to 89%	68 to 88%
Share Ride	4 to 12%	4 to 13%
Drive to Transit	0 to 1%	0%
Walk to Transit	0 to 7%	0 to 7%
Non-Motorized	5 to 21%	5 to 22%

Traffic Assignment

After running the resident and visitor models, all of the person tours are converted into zone-to-zone trip tables that are assigned to the street network. TMPO/TRPA uses TransCAD transportation software to perform traffic assignment for each time of day period. The breakdown of time periods in the TMPO/TRPA ABM is shown in Table 13. Because there are very few trips of the transit and non-motorized modes, TMPO/TRPA only assigns the drive-alone and shared auto trips to the street network.

Table 13: Time Periods Used in Activity Based Model

Time Period	Start Time	End Time
AM Peak (AM)	7:00 AM	10:00 AM
Midday (MD)	10:00 AM	4:00 PM
PM Peak (PM)	4:00 PM	7:00 PM
Late Night (LN)	7:00 PM	7:00 AM

TMPO/TRPA uses the standard Bureau of Public Roads (BPR) volume-delay function (VDF) to estimate travel time, given the free-flow travel time, capacity, and assigned volume for each link in the street network. The coefficients used in the capacity sensitive assignment function were consistent with FHWA's guidelines. All inter-zonal trips are iteratively assigned to the shortest calculated path by time. For each iteration, TMPO/TRPA applies the Method of Successive Averages (MSA)[12] to update the link volumes. TMPO/TRPA uses convergence criteria of 0.0001 during model development. A maximum of 50 iterations was found to reach convergence.

Table 14 presents a comparison between the assigned traffic volume to the transportation network and the observed data.

Table 14: Regional Assigned Traffic Volume and Traffic Counts

Trip Type	Assigned Volume	External Station Counts
Summer - Travel into Region	33,691	33,663
Summer - Travel out of Region	33,691	33,576
Winter - Travel into Region	26,813	26,752
Winter - Travel out of Region	26,813	26,663

Model Validation and Model Improvement

The last step of model development is model validation, which adjusts model results to reflect traffic count observations. The 2010 CTC's RTP guidelines recommend both static[13] and dynamic[14] tests for model validation to be performed for a region the size of the TMPO region (see Appendix A for more details). TMPO/TRPA established internal and external traffic count stations at 24 selected roadway segments covering both the

[12] The Method of successive averages is a common mathematical approach for finding convergence in link volume estimation process between iterations.
[13] Static validation tests compare the model's prediction of traffic volumes against existing traffic counts.
[14] Dynamic validation tests evaluate the model's response to changes in land use and transportation system assumptions.

California and Nevada sides of the Tahoe Basin for base year (2010) static model validation.

Table 15 presents the model validation results for external-internal and internal-external trips based on summer external station counts. All of the TMPO/TRPA's model results meet the criteria for acceptance given in the CTC's RTP guidelines.

Table 15: Base Year Static Model Validation Results

Validation Item	TMPO/TRPA's Model Result	CTC's RTP Guideline Criteria for Acceptance
Percent of Links within Allowable Deviation	75%	≥75%
Correlation Coefficient	0.93	≥0.88
Percent Root Mean Squared Error (% RMSE)	23%	≤40%

Note: The deviation is the difference between the model volume and the actual count divided by the actual count. This is an indication of the correlation between the actual traffic counts and the estimated traffic volumes from the model. RMSE is the square root of the model volume minus the actual count squared divided by the number of the counts.

TMPO/TRPA also performed eight dynamic validation tests to examine the responsiveness of the model to land use changes within and outside of the pedestrian-transit oriented development (PTOD) areas. The model responses to changes in VMT or vehicle trips with respect to changes in land use are reasonable in these dynamic validation tests.

The in-use day visitor survey does not indicate which external station the travel party used to enter the region, or whether a travel party did activities together. TMPO/TRPA staff states future modeling enhancement will focus on visitor travel survey improvement.

As described in previous sections of this report, TMPO/TRPA's preferred scenario, Alternative 3 / Strategy C combination, proposes low development and highly incentivized redevelopment. Land use and demographic data inputs and assumptions associated with the preferred scenario were input to the activity-based travel demand model to estimate VMT of base and forecasted years. Main data inputs are the region's household, employment, and population information.

Using the ABM alone, the resulting VMT estimates for year 2020 and 2035 demonstrate a corresponding 9 percent and 3 percent per capita CO_2 emissions reduction relative to that of the base year (2005), respectively. TMPO/TRPA staff indicates that most of the projects that are proposed in their 2035 RTP/SCS will be implemented between 2010 and 2020. Therefore, the intermediate percent of CO_2 emissions reduction by 2020 reflects the distribution of the implementation of projects towards early years of the 2010 to 2035 time frame.

Post-Processor Model

The TRIA model, a post-processing tool, was developed by TMPO/TRPA to evaluate trip reduction impacts associated with the RTP/SCS strategies that were not captured by the ABM. These strategies include parking management, transportation demand management, transit service and facilities improvement, and bike and pedestrian facilities improvement.

The TRIA model uses base year (2005) conditions in the Tahoe region, and forecasts for target years 2020 and 2035. The trip reduction impacts of the selected SCS strategies are derived from region specific standards such as the TRPA Code of Ordinances, the Tahoe Regional Transit System Plan Study, as well as empirical studies conducted elsewhere e.g., the Transit User Surveys in Brussels, Belgium, and Valuing Transit Service Quality Improvements by the Victoria Transport Policy Institute. Where there is variation regarding the effectiveness of a strategy, TMPO/TRPA assumes the more conservative end of the range. Therefore, the potential reduction in VMT may be under-estimated. For consistency purposes, ARB staff reviewed and compared the claimed percent reduction associated with each of the policies used in the TRIA model with available empirical literature findings.

Parking Management

The parking management strategy in the SCS is based in part on the reduction or elimination of minimum parking standards, creation of maximum parking standards, shared parking, and alternative payment methods for parking. TMPO/TRPA estimated vehicle trip reduction associated with parking management policy based on vehicle trip generation rates, projected public and private parking spaces, the number of occupied housing units, household vehicle ownership, and residential occupancy rates. These data were derived from the American Community Survey 2009 (ACS 2009) and the 2000 U.S. Census data.

TRPA/TMPO estimates that parking management would reduce the generation of work trips and discretionary trips from new development by 0.4 percent and 0.9 percent in 2020 and 2035, respectively. The parking management strategy also applies demand-responsive pricing to on-street parking spaces in commercial areas. However, because of relatively few on-street parking spaces currently in commercial areas TMPO/TRPA does not expect significant reductions in vehicle trips for either existing or new developments.

TMPO/TRPA’s assumptions and inputs used in the estimation of vehicle trip reduction are reasonable and consistent with observed data from U.S. Census.

Transportation Demand Management (TDM)

The transportation demand management strategy calls for improving existing employer vehicle trip reduction programs, which include carpool and vanpool matching programs, employee shuttles, on-site secure bicycle storage and shower facilities, flexible work hours, and park-and-ride incentives. This estimate was based on calculating the percent of CO_2 emissions reduction associated with the TDM strategy based on rideshare information and the current[15] and target participation rates for small, medium, and large business firms. The TRIA model assumed target participation rates of 75 percent, 90 percent, and 100 percent for small, medium, and large companies, respectively. TMPO/TRPA estimated that TDM strategies can reduce peak-hour commuter trips by 1.8 percent for existing development and 1.5 percent in new development for both years 2020 and 2035.

ARB staff reviewed key model inputs for the CO_2 emission reduction from the TDM. The model inputs and assumptions are consistent with the TRPA Code of Ordinances[16].

Transit Service and Facilities

TMPO/TRPA projected transit ridership for 2020 and 2035 based on the 2005 Tahoe Area Regional Transit Systems Plan Study and the 2006 Tahoe Interregional/ Intraregional Transit Study. Public transit (i.e. bus) shares about one percent of the total number of trips in 2005. TMPO/TRPA assumes that 95 percent of the forecasted ridership would be from existing single-occupancy-vehicle (SOV) trips.

The transit service and facilities strategy used in the TRIA model considers capital investment or improvement such as intra-regional transit capital projects, transit operational changes, transit coordination improvements on trip planning, real-time arrival information, and transit coordination improvements on wait time and ticketing structure.

TMPO/TRPA expects the transit strategy will increase transit mode share for both work related and discretionary trips. The percent CO_2 emissions reduction estimation is based on the new transit trips and the forecast total number of trips in 2020 and 2035.

Table 16 lists the expected percent reduction associated with each policy. Modeling assumptions for this strategy were reviewed, and found to be consistent with the referenced case studies.

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[15] Current participation rates of the employer vehicle trip reduction program are 30%, 50%, and 80% for small, medium, and large companies, respectively.

[16] The TRPA Code of Ordinances is designed to implement the goals and policies in a manner attaining and maintaining the environment thresholds for the Lake Tahoe region.

Table 16: Assumption on the Transit Service and Facility Strategy

Transit Service and Facility Policy	Percent Reduction in Vehicle Trips	
	2020	2035
Intra-Regional Transit Capital Projects	0.54%	0.50%
Transit Operational Changes	0.82%	0.80%
Transit Coordination Improvement: Trip Planning	1.00%	1.00%
Real-Time Arrival Information	0.50%	0.50%
Transit Coordination Improvement: Wait time and Ticketing Structure	0.09%	0.10%

Bike and Pedestrian Facilities Improvement

TMPO/TRPA estimated bicycle and pedestrian trips based on their 2009 Bicycle Trail User Model. The bike and pedestrian facility strategy intends to complete the bike and pedestrian facility network throughout the Tahoe region. In addition, the SCS includes a snow removal program for important bike and pedestrian routes near the Tahoe Town Centers to keep routes clear during the winter season. TMPO/TRPA expects this strategy can increase bike and pedestrian mode share in the project areas with the reduction mainly drawn from the existing short-distance (3 miles or less) vehicle trips for work and discretionary trip purposes.

Table 17 summarizes the assumed reduction from this strategy. The methodology used in estimating the percent vehicle trip reduction associated with this strategy was reviewed, and found to be appropriate.

Table 17: Assumption on the Bike and Pedestrian Strategy

Bike and Pedestrian Facility Policy	Percent Reduction in Vehicle Trips	
	2020	2035
Complete Region-wide Bike and Pedestrian Network	0.3-0.4%	0.6-0.9%
Snow Removal on Important Bike and Pedestrian Routes	0.05-0.07%	0.1-0.2%

EMFAC Model

ARB’s Emission Factor model (EMFAC2011) is a California-specific computer model which calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses for calendar years 1990 to 2035. The model estimates exhaust and evaporative hydrocarbons, carbon monoxide, oxides of nitrogen, particulate matter, oxides of sulfur, methane, and CO_2 emissions. It uses vehicle activity provided by regional transportation planning agencies, and emission rates developed from testing of in-use vehicles. The model estimates emissions at the statewide, county, air district, and air basin levels.

The EMFAC2011 modeling package contains three components: EMFAC2011-LDV for light-duty vehicles, EMFAC2011-HD for heavy-duty vehicles, and EMFAC2011-SG for future growth scenarios. To estimate per capita CO_2 emissions, TMPO/TRPA estimated total VMT and speed profiles for the California portion of the region and applied them to the EMFAC2011-SG model. EMFAC2011-SG uses the inventory from EMFAC2011-LDV and EMFAC2011-HD modules and scales the emissions based on changes in total VMT, VMT distribution by vehicle class, and speed distribution. TMPO/TRPA then divided the estimated CO_2 emissions by the year 2005, 2020, and 2035 residential populations to obtain CO_2 emissions per capita.

Overall Adjustment Impacts

TMPO/TRPA considers the preferred alternative (Alternative 3/Strategy C) to be a moderate level of deployment for the combined implementation of the parking management, TDM, transit service improvement, and bike and pedestrian facility improvement strategies.

TMPO/TRPA applied the forecasted land use and population growth data inputs associated with the preferred scenario alone to the activity-based travel demand model. The outputs of this analysis show a 9 percent and 3 percent per capita CO_2 emissions reduction by 2020 and 2035 respectively, compared to that of 2005. For its RTP/SCS, TMPO/TRPA staff also used the TRIA model to analyze the CO_2 emissions reduction impacts associated with different level of deployment for the combined implementation of strategies that are not reflected in the ABM.

Outputs of the TRIA model indicate the implementation of these strategies can contribute an additional 3 percent and 4 percent per capita CO_2 emissions reduction by 2020 and 2035 respectively, compared to that of 2005. Together, the application of the activity-based travel demand model and the TRIA model to Alternative 3/Strategy C results in a 12 percent and 7 percent per capita CO_2 emissions reduction by 2020 and 2035, respectively.

PERFORMANCE INDICATORS

Because of the unique characteristics of the Tahoe region, ARB staff focused on two key performance indicators, residential density and VMT. ARB staff reviewed the directional consistency of the indicators with TMPO/TRPA's modeled GHG emissions reductions, as well as the general relationships between those indicators and GHG emissions identified in the empirical literature. This assessment relies on key empirical studies for each indicator that illustrate qualitatively how changes can increase or decrease VMT and/or GHG emissions. Below is a summary of ARB staff's evaluation for the land use and transportation-related performance indicators.

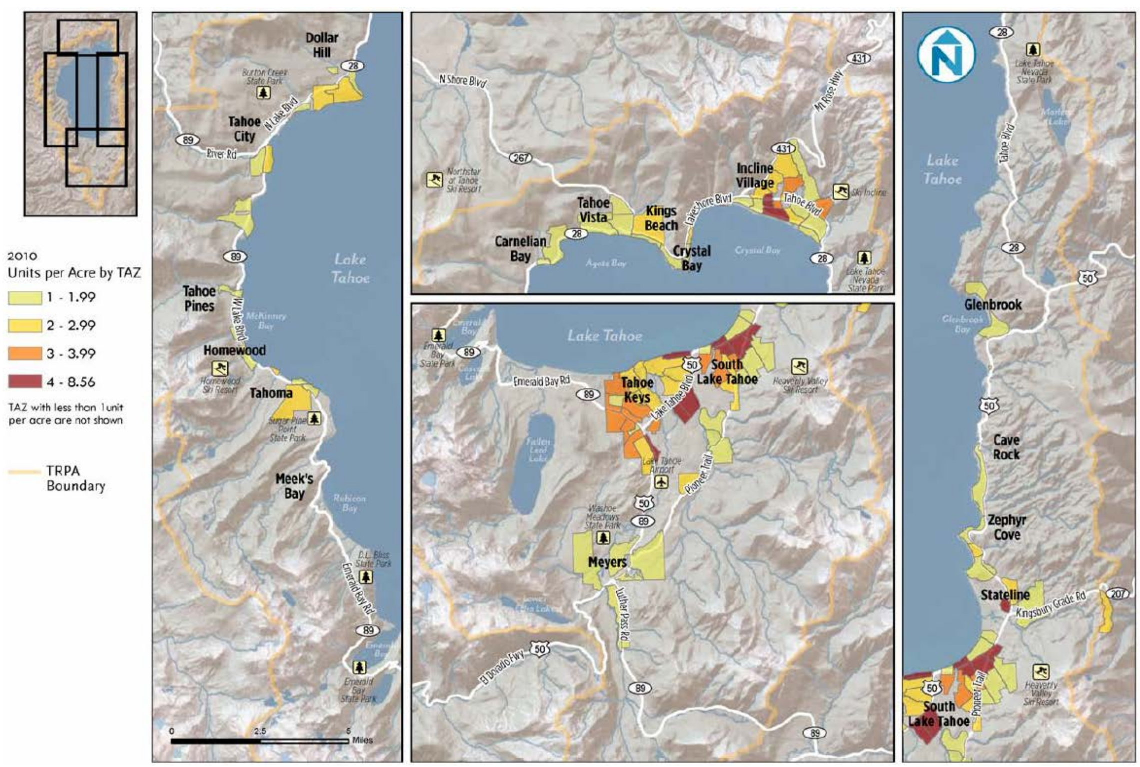
Land Use Indicators

ARB staff's review focused on residential density to evaluate changes in passenger vehicle GHG emissions reductions from development patterns assumed in the preferred alternative scenario.

Residential density is a measure of the average number of dwelling units per acre of developed land. TMPO/TRPA anticipate a change in travel characteristics in the region as the housing market shifts from single unit homes on larger lots, to single unit homes on smaller lots, townhomes, and multi-family housing. These changes in travel behavior include reductions in average trip length, and could eventually result in decreased regional VMT.

A review of relevant empirical literature supports the TMPO/TRPA finding that decreased regional VMT should result from increased residential density. Brownstone and Golob analyzed National Household Travel Survey (NHTS) data and observed that denser housing development significantly reduces annual vehicle mileage and fuel consumption, which directly results in the reduction in GHG emissions. They also reported that households in areas with 1,000 or more units per square mile drive 1,171 fewer miles and consume 64.7 fewer gallons of fuel than households in less dense areas. Boarnet and Handy (2010) reported that doubling residential density reduces VMT an average of 5 to 12 percent. Litman (2012) reported that increased population density leads to a decrease in the demand for car travel.

Figure 8: Existing Distribution of Residential Development, 2010

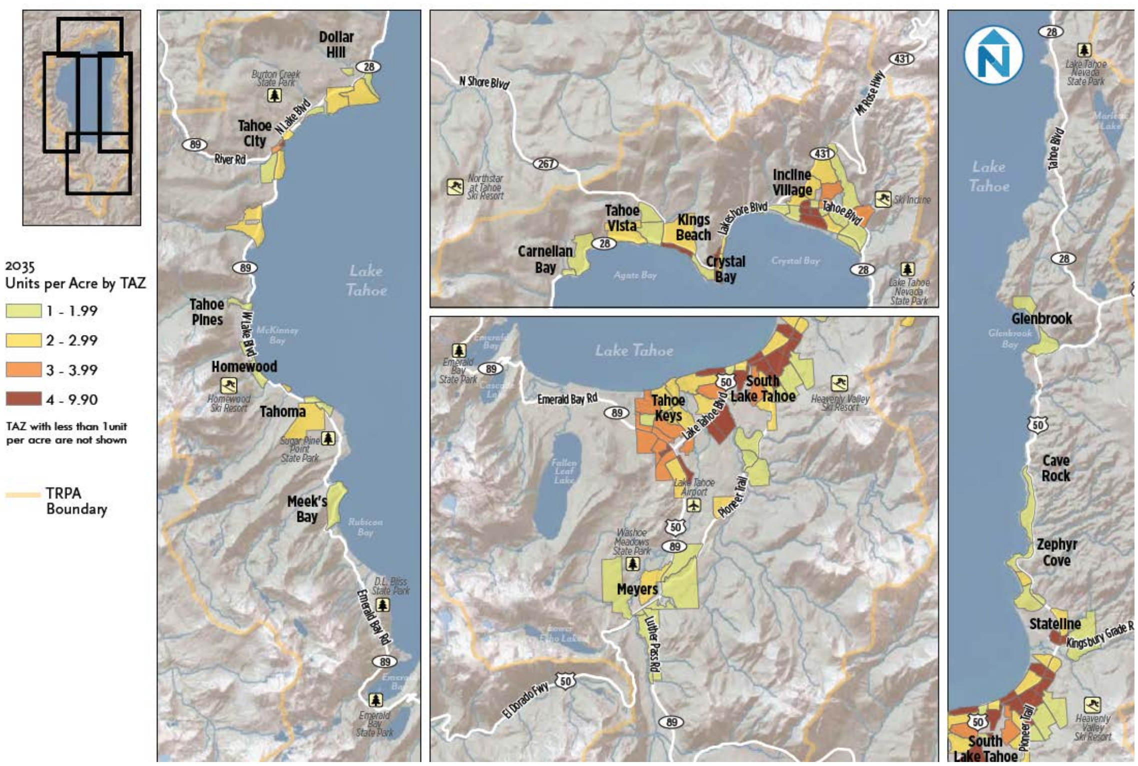


The Tahoe region currently contains 47,000 dwelling units. Roughly 31,000 are single-family homes on medium-sized lots ranging from 1/8 to 1/4 acre. Figure 8 shows the existing distribution of Tahoe's residential development.

The RTP/SCS indicates that the number of housing units will rise, especially multi-family housing in town centers, thus increasing residential density. Tahoe's preferred land use alternative (Alternative 3 linked to Transportation Strategy C) would result in the highest level of redevelopment activity, with somewhat higher densities in community centers.

Of the five alternatives evaluated, the preferred land use alternative calls for the highest level of environmental restrictions on development, removal of existing development, and transfer of development rights from sensitive lands and lands distant from the community centers. Figure 9 shows the projected distribution of new residential development in the Tahoe region in 2035.

Figure 9: Forecast Distribution of Residential Development, 2035

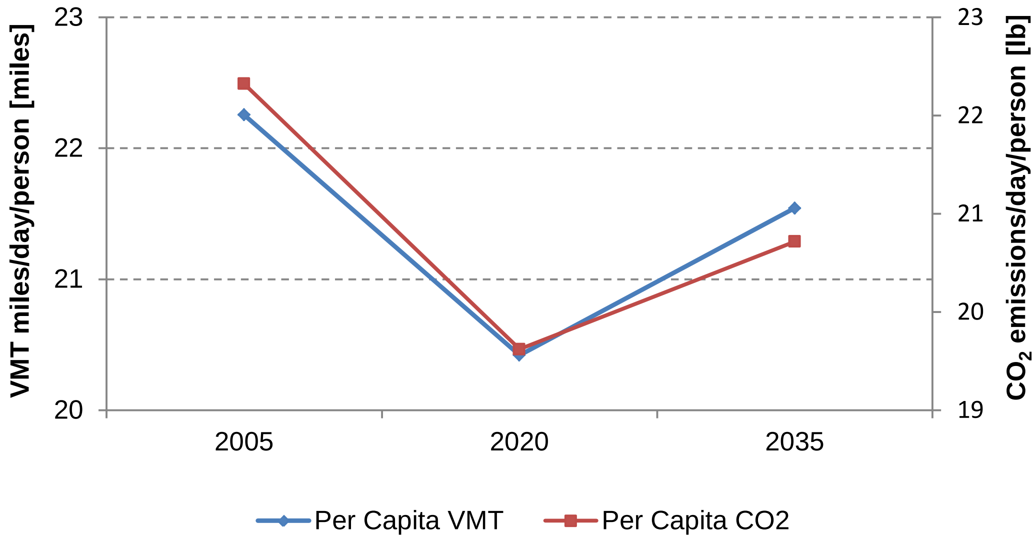


The empirical literature supports the finding that increased density will likely result in reductions in VMT and auto trip length, shifts in travel mode away from single occupancy vehicles, and associated reductions in GHG emissions.

Transportation-Related Indicators

Passenger VMT was evaluated as a transportation-related performance indicator of the TMPO/TRPA activity-based travel demand model. The weekday per capita passenger vehicle VMT for 2005, 2020, and 2035 is illustrated in Figure 10 below. TMPO/TRPA staff indicates that the large reduction in both per capita weekday VMT and CO_2 emissions between years 2005 and 2020 reflect most of the proposed projects included in their 2035 RTP/SCS will be implemented by 2020. Development in 2005 in the TMPO/TRPA region was greater than in 2012. Therefore, the loss in tourist accommodations units (TAUs) after the 2005 peak development period contributes to the rapid reduction in per capita CO_2 emission between 2005 and 2020.

Figure 10: Weekday Per Capita Passenger Vehicle VMT and CO_2



The estimation of CO_2 emissions from passenger vehicles is based on VMT and vehicle travel speeds. The base year and forecasted VMT of TMPO/TRPA are directionally consistent with the corresponding reported CO_2 emissions reduction trend between 2005 and 2035 in their RTP/SCS.

CONCLUSION

This report documents ARB staff's technical review of the plan together with its subsequent review of the adopted RTP/SCS. This review affirms that TMPO/TRPA's adopted SCS demonstrates that, if implemented, the region will achieve a 12.1 percent passenger vehicle greenhouse gas per capita reduction in 2020, and a 7.2 percent reduction in 2035. These reductions meet the targets established for TMPO/TRPA of 7 percent and 5 percent GHG per capita decrease from 2005 levels for the years 2020 and 2035, respectively.

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Appendix A: 2010 CTC RTP Guidelines Addressed in TMPO/TRPA's RTP

This Appendix describes the requirements in the CTC Guidelines that are applicable to the TMPO/TRPA regional travel demand model, as well as the recommendations that TMPO/TRPA incorporated into the model.

Requirements	1. 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. 2. MPO models shall be capable of estimating future transportation demand at least 20 years into the future. (Title 23 CFR Part 450.322(a)) 3. 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)) 4. 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)) 5. 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)) 6. 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))
Recommendations	1. The use of three-step models can continue for the next few years. The models should be run to a reasonable convergence towards equilibrium. 2. 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. 3. 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. 4. The models should address changes in regional demographic patterns. 5. Geographic Information System (GIS) capabilities should be developed in these counties, leading to simple land use models in a few years. 6. All natural resources data should be entered into the GIS. 7. Parcel data should be developed within a few years and an existing land use data layer created. 8. For the current RTP cycle (post last adoption), MPOs should use their current travel demand model for federal conformity purposes, and a suite of analytical tools, including but not limited to, travel demand models (as described in Categories B through E), small area modeling tools, and other generally accepted analytical methods for determining the emissions, VMT, and other performance factor impacts of sustainable communities strategies being considered pursuant to SB 375. 9. 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. 10. 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. 11. 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. 12. 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. 13. When the transit mode is modeled, speed and frequency, days, and hours of operation of service should be included as model inputs. 14. When the transit mode is modeled, the entire transit network within the region should be represented. 15. 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. 16. 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.

Appendix B: Modeling Parameters for SCS Evaluation (Data Table)

This appendix contains TMPO/TRPA's responses to data requests, received on October 11, 2012, to supplement ARB staff's evaluation of TMPO/TRPA's quantification of GHG emissions. ARB requested this data in accordance with the general approach described in ARB's July 2011 evaluation methodology document (or the modified evaluation methodology document).

Modeling Parameters[17]	2005 (if available)	2010 (base year)	2020 (Without Project)[18] (With Project)[19]		2035 (Without Project)[2] (With Project)[3]		Data Source
DEMOGRAPHIC							
Total population	R=55,232; CA=41,213	R= 54,473; CA=41,176	R=55,132: CA=41,709	R=58,049; CA=43,934	R=55,687; CA= 42,005	R=60,365; CA=45,468	RPU Draft EIS page 3.12-9, and TMPO Model
Group quarters population	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	
Total number of households	R=22,729; CA=16,960	R=22,417; CA=16,945	R=23,460; CA=17,749	R=24,701; CA=18,695	R=23,696; CA=17,874	R=25,687; CA=19,348	Total population divided by Persons per household, below
Persons per household	R=2.43	R=2.43	R= 2.35	R=2.35	R=2.35	R=2.35	U.S. Census, and TMPO Model
Auto ownership per household	R=1.9	Not available	Not available	Not available	Not available	Not available	2005 Tahoe Regional Household Travel Survey, p. i.
Total employees	R=26,800 CA=12,715	R=22,605; CA=11,354	R=22,735; CA= 11,594	R=23,143; CA= 12,034	R=23,393; CA=11,930	R=23,804; CA= 12,854	RPU Draft EIS page 3.12-10, and TMPO Model
Average unemployment rate (%) (*Not used in model)*		13.1%	Not applicable	Not applicable	Not applicable	Not applicable	Base Year = CA Employment Development Department of Labor Market Information Division and NV. Department of Employment Training and Rehabilitation. Unemployment not used in Model.

[17] When reporting $ units, indicate whether they are current dollars, YOE (year of exchange), or other.

[18] This scenario excludes proposed projects in RTP/SCS for respective calendar year. In other words, do nothing.

[19] This scenario includes modeling of proposed projects in RTP/SCS for respective calendar year.

Note: R= Tahoe Region (including Nevada) CA= California Portion of Tahoe Region

Average household income ($) (*Not used in model)*	R=$53,364 (2005 dollars)	R=$58,754 (2010 dollars)	Not applicable	Not applicable	Not applicable	Not applicable	U.S. Census
LAND USE							
Total housing/dwelling units	R=46,360: CA=33,897	R=47,392: CA=35,260	R=47,938: CA=35,543	R=50,412: CA= 37,809	R=48,352: CA=35,780	R=51,552: CA=38,921	RPU Draft EIS, page 3.12-10, and TMPO Model
Single family households	Not available	R=40,592	Not available	Not available	R=40,678	R=42,158	Single-family Households are equal to Total housing/dwelling units minus multi-family households from below.
Multi-family households	Not available	R=6,800 (2012, approximate)	Not available	Not available	R=7,674	R=9,394	2010 data multi-family households is based on a query on November 20, 2012 of the TRPA Parcel database joined to PARCEL_APO, for all parcels with Description, 'Multiple family dwelling (2-4 units)', 'Multiple family dwelling (5-10 units)' or 'Multiple family dwelling (10+ units)'. Summed the number of units in the “Units” field for all selected parcels. 2035 data is 2012 plus new Multi-Family Residential from Table 2 (p. H-3) in Appendix H, RPU Draft EIS.
Average density – dwelling units per acre. Note: Density only includes Single Family Residential Units	CA= 1.99	CA= 2.07	CA=2.09	CA=2.22	CA= 2.1	CA=2.29	Total Housing/Dwelling units (from above) divided by total acreage of the urban boundary for Lake Tahoe’s California jurisdictions (17,011 acres), from TRPA GIS data, UrbanAreas shapefile, November 19, 2011.
Tourist Accommodation Units	R=12,959	R=12,399	R=12,741	R=12,741	R=12,741	R=12,741	RPU Draft EIS, page 3.2-17, and TMPO Model

Regional housing vacancy rate (%) *(modeled)*	Not available	45% vacant (includes units used seasonally and vacant)	45% vacant (includes units used seasonally and vacant)	45% vacant (includes units used seasonally and vacant)	45% vacant (includes units used seasonally and vacant)	45% vacant (includes units used seasonally and vacant)	2000 U.S. Census (2010 Census data was not available for vacancy rates at the time the 2010 base year was developed, so 2000 rates were used).
Total acreage developed	Not available (but similar to 2010)	R=7,936 (Hard coverage = 6,164 Soft coverage=1,771)	Not Calculated	Not Calculated	New acreage developed R=7 (commodities) + 28 (bike trails) = 35	New acreage developed R=66 (commodities) + 52 (bike trails) + 65 (temporary coverage and ADA) = 183	-2010 coverage from Table 3.2, page 3-23 of the Final RPU EIS (Revised Estimate of Total Area of Impervious Coverage, 1974 Bailey) -2035 Coverage estimates, page 3-139 of Final RPU EIS, and TRPA GIS layers
Total acreage available for new Development	Not available (but similar to 2010)	R=252	Not calculated	Not calculated	R=252	R=281	Derived from Tables 6 in Appendix H of the draft Regional Plan EIS (p. H-6) and Table C-2 of Appendix C of the Final RPU EIS (p. C-4, Alternative 1 and "Final Draft Plan"). Total acreage is: ([Total vacant private land available in each land capability district (Table 6)] x [Base allowable land coverage coefficients from Table 30.4.1-1 in the TRPA draft Code of Ordinances]) + (Allowable new coverage in community centers (Table C-2)).

Total housing units and tourist units within 1/4 mile of transit stations and stops	R=30,800	Not available	R=31,441	R=32,482	R=31,855	R=33,575	2005: -Source: TRPA GIS Analysis conducted in 2006, for the Pathway Evaluation Report, V1.1. Filename: overnightpopulation_access_standards_table.xls.shp; -2020 and 2035: Filename: future_trans_2035_quart_mile_Parcels_2012_int.shp -Plus new development allocations, filename: regional_plan_allocations_for_ascent_2012.03.02.xls.
New housing units and tourist units within 1/4 mile of transit stations and stops	Not applicable	Not applicable	R=802	R=1,843	R=1,216	R=2,936	New development allocations, filename: regional_plan_allocations_for_ascent_2012.03.02.xls.
Total housing and tourist units within 1/2 mile of transit stations and stops	Not available	Not available	Not available	Not available	Not available	Not available	
New housing and tourist units within 1/2 mile of transit stations and stops	Not applicable	Not applicable	R=802	R=1,843	R=1,216	R=2,936	New development allocations, filename: regional_plan_allocations_for_ascent_2012.03.02.xls.
Total employment (employees) within 1/4 mile of transit stations and stops	R=24,900	R=20,700	Not available	Not available	R=21,500	R=21,900	2005 Source: TRPA GIS data. Filename: transit_summer_2006_quart_mile_empl_int.shp, Column 2005_HH_25. 2010 Source: TRPA GIS data. Filename: transit_2006_quart_mile__2010_emp_int, Column 2010_Wo_47 2035 Source: Difference in payroll employees between 2035 and 2010, from Table 3.12-2, page 3.12-10 of the RPU Draft EIS.
New employment (employees) within 1/4 mile of transit stations and stops	Not applicable	Not available	Not available	Not available	R=800	R=1,200	Source: Difference in payroll employees between 2035 and 2010, from Table 3.12-2, page 3.12-10 of the RPU Draft EIS (all new employment expected to be in town centers)

Total employment (employees) within 1/2 mile of transit stations and stops	R=25,300	R=21,250	Not available	Not available	R=22,000	R=22,500	2005: Source: TRPA GIS data. Filename: transit_summer_2006_half_mile_empl_int.shp, Column 2005_HH_25. 2010: Filename: transit_2006_half_mile_buf_emp_2010_int.shp, Column 2010_Wo_47. 2035 Source: Difference in payroll employees between 2035 and 2010, from Table 3.12-2, page 3.12-10 of the RPU Draft EIS (all new employment expected to be in town centers).
New employment (employees) within 1/2 mile of transit stations and stops	Not applicable	Not available	Not available	Not available	R=800	R=1,200	Source: Difference in payroll employees between 2035 and 2010, from Table 3.12-2, page 3.12-10 of the RPU Draft EIS (all new employment expected to be in town centers).
TRANSPORTATION SYSTEM							
Freeway general purpose lanes –- mixed flow(lane miles)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Freeway managed lanes—HOV, HOT, Tolled, etc. (lane miles)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Freeway auxiliary lanes (lane miles)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Freeway new ramps or widened ramps (lane miles)	Not applicable, no freeways	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Major Arterial / Expressway (lane miles)	Not applicable, All State Routes are coded as Minor Arterials	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Minor Arterial (lane miles)	R=110	R=110	R=110	R=110	R=110	R=110	TMPO Model
Collectors (lane miles)	R=155	R=155	R=155	R=155	R=155	R=155	TMPO Model
Locals (lane miles)	R=464	R=464	R=464	R=464	R=464	R=464	TMPO Model
Bus, operation miles (per day)	Not available	R=3,640	R=4,250	R=4,250	R=5,100	R=5,100	Tahoe Transportation District; South Shore Short Range Transit Plan.
Transit rail operation miles	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Transit total daily vehicle service hours -	Not available	R= 409	R=460	R=460	R=520	R=520	Tahoe Transportation District; Short Range Transit Plan.

Bike Path miles	R= 33 (in 2003)	R= 43 CA=31	Not available	Not available	R=53 CA=37	R=62 CA=44	Lake Tahoe Regional Bicycle and Pedestrian Master Plan, 2003 Lake Tahoe Region Bicycle and Pedestrian Plan, 2010 2035: Draft 2012 RTP Constrained Project List; Also, "Prop_Bikeways_RPU_upd_2012.10.shp" plus Sawmill 2a and Lakeside Trails (constructed)
Bike Lane miles	R= 26 (in 2003)	R=21 CA=17	Not available	Not available	R=32 CA=28	R=32 CA=28	Lake Tahoe Regional Bicycle and Pedestrian Master Plan, 2003 Lake Tahoe Region Bicycle and Pedestrian Plan, 2010 2035: Draft 2012 RTP Constrained Project List; Also "Prop_Bikeways_RPU_upd_2012.10.shp" plus constructed Tahoe City to Kings Beach and Trout Creek to Ski Run Blvd. Bike Lanes.
Sidewalk miles	Not available	R=12 CA=6	Not available	Not available	R=13 CA=7	R=15 CA=8	Lake Tahoe Regional Bicycle and Pedestrian Master Plan, 2003 Lake Tahoe Region Bicycle and Pedestrian Plan, 2010 2035: Draft 2012 RTP Constrained Project List; Also "Prop_Bikeways_RPU_upd_2012.10.shp."
TRIP DATA (new)							
Number of Work Trips per day	Not available	R=22,502 Tours	R=24,621 Tours	R=25,273 Tours	R=25,112 Tours	R=26,721 Tours	TMPO Model.
Number of Shop Trips per day	Not available	R=8,911 Tours	R=10,102 Tours	R=10,812 Tours	R=10,489 Tours	R=11,453 Tours	TMPO Model.
Average Number of Trips/person per day by Mode	Household Survey = 9.61 Auto Trips per Household	Auto = 9.61	Auto= 9.71	Auto=9.70	Auto=9.63	Auto=9.62	2005 = Household Survey – Model Output
TOUR DATA							
Number of tours per day	Not available	R=108,265	R=109,432	R=110,588	R=110,867	R=112,409	TMPO Model

Primary destination	Not available	R=Work - 22,502	R=Work-24,621	R=Work-25,273	R=Work-25,112	R=Work-26,721	TMPO Model.
Secondary destination	Not available	Not available	Not available	Not available	Not available	Not available	
Number of stops in primary tour	Not available	R=7,726	R=7,987	R=8,421	R=8,124	R=8,845	TMPO Model.
Number of stops in secondary tour	Not available	Not available	Not available	Not available	Not available	Not available	
Tour distance	Not available	Resident = 11.7 Visitor = 22.5	Resident=11.5 Visitor=22.8	Resident=11.3 Visitor=22.6	Resident=11.5 Visitor=22.9	Resident=11.3 Visitor= 22.6	TMPO Model
Average auto trip length (miles)	Not available	R= 18.69	R=18.71	R=19.11	R=18.902	R=18.97	TMPO Model.
Average walk trip length (miles) *Not modeled*	R=1.8	R=1.8	R=1.8	R=1.8	R=1.8	R=1.8	TMPO Bicycle Trail User Model
Average bike trip length (miles) *Not modeled*	R=2.4	R=2.4	R=2.4	R=2.4	R=2.4	R=2.4	TMPO Bicycle Trail User Model
Average transit trip length (miles)	Not available	Not available	Not available	Not available	Not available	Not available	
Tour duration (minutes)	Not available	Not available	Not available	Not available	Not available	Not available	
Primary tour duration (minutes)	Not available	Not available	Not available	Not available	Not available	Not available	
Secondary tour duration (minutes)	Not available	Not available	Not available	Not available	Not available	Not available	
PERCENT TRIP MODE SHARE (whole day) Mode Share in the model is based on the 2006 Summer Travel Survey							
SOV/HOV	82%	81%	82%	82%	82%	82%	Travel Mode Share Surveys, Summer 2006 and 2010
Public transit (Bus)	1%	1%	1%	1%	1%	1%	Travel Mode Share Surveys, Summer 2006 and 2010
Public transit (Rail)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Non-motorized: Bike	4%	6%	4%	4%	4%	4%	Travel Mode Share Surveys, Summer 2006 and 2010
Non-motorized: Walk	12%	10%	12%	12%	12%	12%	Travel Mode Share Surveys, Summer 2006 and 2010
Other (includes paratransit, casino shuttle, private shuttle, ferry/boat, and taxi/limo)	1%	2%	1%	1%	1%	1%	Travel Mode Share Surveys, Summer 2006 and 2010

Additional Trip Reductions to the Mode Share listed above	Not applicable	Not applicable	Urban Centers: 2.3% Other Areas: 0.8% Internal-External: 0.8%	Urban Centers: 3.7% Other Areas: 1.7% Internal-External: 0.8%	Urban Centers: 2.7% Other Areas: 1.3% Internal-External: 0.8%	Urban Centers: 4.3% Other Areas: 2.2% Internal-External: 0.8%	TMPO Trip Reduction Impact Analysis (TRIA) model (see Appendix E, Part 2 (TRIA spreadsheets) of the RPU Draft EIS for trip reductions by mode).
PERCENT TRIP MODE SHARE (Peak period)							
SOV	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	
HOV/HOT	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	
Public transit (Bus)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	
Public transit (Rail)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	
Non-Motorized: Bike	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	
Non-Motorized: Walk	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	
AVG. TRAVEL SPEED (MPH)	Not available	R=25.87	R=25.85	R= 25.83	R=25.92	R=25.37	TMPO Model
VEHICLE MILES TRAVELED							
Total VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2 and MDV) (miles)	CA—850,203	CA- 760,129	2020 Alt 1 CA – 786,694	2020 Alt 3 CA – 783,512	2035 Alt 1 CA – 832,554	2035 Alt 3 CA – 856,151	TMPO Model and EMFAC Output Files from 3/26/2012
Total VMT per weekday for passenger vehicles (All vehicle classes) (miles)	CA – 949,750	CA- 909,181	CA- 928,908	CA-925,150	CA-989,899	CA-1,017,955	Appendix E, Part 4, RPU Draft EIS (Appendix C, Part 4, RTP Draft EIR/EIS)

Total II (Internal) VMT per weekday for passenger vehicles (All vehicle classes) (miles)	CA-495,722	CA-466,838	CA-480,081	CA-474,780	CA-505,555	CA- 535,198	Appendix E, Part 4, RPU Draft EIS (Appendix C, Part 4, RTP Draft EIR/EIS)
Total* IX/XI VMT per weekday for passenger vehicles (All vehicle classes) (miles) (*50% of IX/XI VMT)	CA-454,028	CA-442,343	CA-448,828	CA-450,371	CA-484,344	CA-482,757	Appendix E, Part 4, RPU Draft EIS (Appendix C, Part 4, RTP Draft EIR/EIS)
Total XX VMT per weekday for passenger vehicles(All vehicle classes) (miles)	CA-548,271	CA-633,099	CA-638,240	CA-657,842	CA-666,848	CA-630,293	Appendix E, Part 4, RPU Draft EIS (Appendix C, Part 4, RTP Draft EIR/EIS)
CONGESTED TRAVEL MEASURES							
Congested weekday VMT on freeways (miles, V/C ratios >75)	No Freeways	No Freeways	No Freeways	No Freeways	No Freeways	No Freeways	No Freeways
Congested VMT on all other roadways (miles, V/C ratios >0.75)	Not available	R=415,969 CA=294,010	R=428,631 CA=300,041	R=455,757 CA=319,029	R=513,861 CA=359,840	R=517,016 CA=361,307	TMPO Model (pre-TRIA)
CO2 EMISSIONS[20]							
Total CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons)	CA= 437	Not applicable	CA=411	CA= 409	CA= 435	CA=447	EMFAC Output Files dated 3/26/2012
Total CO2 emissions per weekday for all vehicle classes	CA=551	Not applicable	CA=562	CA=559	CA=605	CA=622	EMFAC Output Files dated 3/26/2012

[20] Please provide ARB staff with the EMFAC Input and Output files associated with these outputs.

Total II (Internal) CO2 emissions per weekday for passenger vehicles (tons)	CA=288	Not applicable	CA=290	CA=287	CA=309	CA=327	Estimated based on proportion of II VMT from above
Total* IX / XI trip CO2 emissions per weekday for passenger vehicles (tons) (*50% of IX/XI CO2)	CA=263	Not applicable	CA=272	CA=272	CA=296	CA=295	Estimated based on proportion of IX-XI VMT from above
Total XX trip CO2 emissions per weekday for passenger vehicles (tons)	CA=318	Not applicable	CA=386	CA=397	CA=408	CA=385	Estimated based on proportion of XX VMT from above
INVESTMENT							
Total plan period investment ($)	Not applicable	Not applicable	$848,843,000	$1,078,000,000	$1,313,000,000	$1,592,000,000	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Highway capacity expansion ($)	Not applicable	Not applicable	0	0	0	0	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Other road ($) Note: Corridor Revitalization	Not applicable	Not applicable	$58,496,000 (to 2023)	$142,960,000 (to 2023)	$58,496,000 (2013-2035)	$142,960,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Transit capacity expansion ($) *Waterborne Transit only*	Not applicable	Not applicable	Capital: $43,900,000 Operations: $41,400,000 (2013- 2023)	Capital: $43,900,000 Operations: $41,400,000 (2013- 2023)	Capital: $43,900,000 Operations: $96,600,000 (2013-2035)	Capital: $43,900,000 Operations: $96,600,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List

Aviation capital ($)	Not applicable	Not applicable	0	0	$22,194,000 (2013-2035)	$22,194,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Bus transit capacity expansion ($)	Not applicable	Not applicable	0	$46,864,000 (2013- 2023)	0	$90,458,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Transit operations ($)	Not applicable	Not applicable	89,500,000 (2013-2023)	89,500,000 (2013-2023)	$212,047,000 (2013-2035)	$212,047,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Rail transit operations ($)	Not applicable	Not applicable	0	0	0	0	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Bike and pedestrian projects ($)	Not applicable	Not applicable	$32,469,000 (2013- 2023)	$75,278,500 (2013- 2023)	$32,469,000 (2013-2035)	$81,227,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Bike and pedestrian operations ($)	Not applicable	Not applicable	$6,234,000 (2013-2023)	$6,234,000 (2013-2023)	$14,778,000 (2013-2035)	$14,778,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Other ($) *Stormwater Strategies*	Not applicable	Not applicable	$384,467,000 (2013- 2023)	$437,072,000 (2013- 2023)	$384,467,000 (2013-2035)	$437,072,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Stormwater Treatment Facilities operations ($)	Not applicable	Not applicable	$22,473,000 (2013-2023)	$22,473,000 (2013-2023)	$53,271,000 (2013-2035)	$53,271,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Other ($) Transportation System Management and Intelligent Transportation Systems	Not applicable	Not applicable	$10,468,000 (2013-2023)	$12,989,000 (2013-2023)	$10,893,000 (2013-2035)	$13,414,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
Other Operations and Maintenance	Not applicable	Not applicable	$159,434,000 (2013-2023)	$159,434,000 (2013-2023)	$383,608,000 (2013-2035)	$383,608,000 (2013-2035)	Final Draft (October 24, 2012) 2012 RTP Constrained Scenario Project List
TRANSPORTATION USER COSTS AND PRICING							

Vehicle operating costs (cents per mile) *Not modeled*	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Gasoline price ($ per gallon) *Not modeled*	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Parking price ($ per day) *Not modeled*	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Toll price ($)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Congestion price ($ per mile) *Not modeled*	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
Average transit fare per passenger mile ($ per mile) *Not modeled*	Not applicable	BlueGo=$1.39 TART= $1.25 Not modeled	Not applicable	Not applicable	Not applicable	Not applicable	