Technical Methodology to Estimate Greenhouse Gas Emissions for the 2024-2045 RTP/SCS from the Butte County Association of Governments

BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

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(revised September 2024)

INTRODUCTION

Purpose

As required by the Sustainable Communities and Climate Protection Act of 2008, and in accordance with Government Code 65080(b)(2)(J)(i), BCAG has prepared this document describing the technical methodology it will use in estimating greenhouse gas emissions from its 2024 Regional Transportation Plan (RTP) and (SCS) Sustainable Communities Strategy. This is intended to be a working document as BCAG, in coordination with the California Air Resources Board (ARB), navigates the development and final acceptance of the 2024 RTP/SCS quantification of greenhouse gas emissions.

Applicable Targets

In 2011, ARB set GHG targets for the BCAG region from passenger vehicles as a 1% increase from 2005 emissions levels by 2020 and a 1% increase from 2005 emissions levels by 2035. BCAG's 2012 RTP/SCS achieved a 2% reduction in per capita GHG emissions for the years 2020 and 2035. Subsequently, BCAG's 2016 RTP/SCS achieved a 6% reduction in per capita GHG emissions for the year 2020 and 7% reduction for 2035.

In 2018, ARB updated the BCAG targets as a 6% decrease from 2005 emissions levels by 2020 and 7% decrease from 2005 emissions levels by 2035. BCAG's 2020 RTP/SCS demonstrated a 14% reduction in per capita GHG emissions for the year 2020 and an 8% reduction for 2035. However, the 2020 RTP/SCS did not receive final approval from ARB. These targets apply to the BCAG region for passenger vehicle emissions, and not to individual cities or sub-regions. The metric used for reporting will be GHG emissions per capita.

Analysis Years

The following table includes the proposed analysis years for BCAG's 2024 RTP/SCS.

Year	Purpose
2005*	Base Year for SB 375 GHG emission reduction Target Setting
2022	Base Year for BCAG 2024 RTP/SCS
2035	SB 375 GHG Emission Reduction Target
2045	BCAG 2024 RTP/SCS Horizon Year

*Note – 2005 baseline information carried over from 2020 RTP/SCS

Schedule

The schedule for the 2024 RTP/SCS, including estimates for the public outreach process, is shown in Attachment A.

OVERVIEW OF EXISTING CONDITIONS

Since the adoption of the last RTP/SCS in December of 2020, the BCAG region has seen a significant loss in population following the 2018 Camp Fire, which has been exacerbated by the 2020 North Complex fire and the COVID-19 Pandemic. In late 2020, the region experienced a second significant wildfire with the 2020 North Complex Fire which destroyed ~1,500 housing units in the unincorporated foothills of eastern Butte County. The COVID-19 Pandemic further disrupted the region's population with the closure of in-person classes at Chico State University and Butte Community College. Chico State University enrollment fell from over 16,000 full-time students in 2019 to less than 13,000 in 2022, a 20% decrease. Overall, the region's population declined from 226,000 in 2018 to a low of 202,000 in 2022. Despite this loss in population, housing growth has remained strong since 2019 in the City of Chico and Town of Paradise with over 700 units a year being produced in each. The ratio of multi-family development has also increased to 44% from 2018-2022.

The decline in transit ridership was worsened with the COVID-19 pandemic but since has been slowly recovering. Recovery from the Camp Fire has been slower than initially anticipated and the updated growth forecasts are reflective of this. The loss of an additional 1,500 housing units associated with the 2020 North Complex fire has added to the regional housing shortage. Work from home increased with the COVID-19 pandemic and seems to have tapered off but remains at greater levels than before.

Regional and Local Planning Context

A summary of recent regional and local land use and transportation planning activities are included below.

- SCS Progress Report – To better inform the development of the 2024 RTP/SCS, BCAG prepared an SCS Progress Report[1] which looked at several indicators for objectives included in the 2020 RTP/SCS, the progress made to date, and related trends over the past 4 years.

- Transit and Non-Motorized Plan[2] and B-Line Routing Study[3] – Following the Camp Fire, BCAG prepared an update to the Transit and Non-Motorized Plan to better identify the needs, following the impacts from the fire, of transit, bike, and pedestrian modes of travel. The B-Line Routing Study was completed in July 2023 and provides detailed changes related to transit service to be implemented over the next 10 years.

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[1] *Sustainable Communities Strategy Progress Report*, Butte County Association of Governments, July 2023 - https://www.bcag.org/documents/planning/RTP%20SCS/2024%20RTP%20SCS/SCS/BCAG-2022-23-SCS-Progress-Report-final.pdf

[2] *2021 Transit and Non-Motorized Plan*, Butte County Association of Governments, April 2021 - https://www.bcag.org/documents/Camp%20Fire/Post-Camp-Fire-Study-Appendix-B.pdf

[3] *B-Line Routing Study*, Butte County Association of Governments, July 2023 - http://www.blinetransit.com/documents/Routing%20Study/B-Line-Routing-Study-Final-COMPRESSED-NO-APPENDICES.pdf

- North Valley Passenger Rail Strategic Plan – BCAG is developing a strategic plan to study expanding passenger rail service northward from the Natomas area in Sacramento to the City of Chico in Butte County, with stops in Plumas Lake, Marysville-Yuba City and Gridley. This service would connect north state residents with the rest of the state rail system including the Early Operating Segment of California High Speed Rail in Merced.

- Regional Travel Survey[4] – The report was developed to inform the development of the 2024 RTP/SCS update, following the impacts of the 2020 North Complex Fire and COVID-19 Pandemic. This report combines demographic and anonymized cellular location data along with survey data from the community and local employers.

- REAP 2.0 – BCAG is working with the local jurisdictions and the California Department of Housing and Community Development to implement projects for the Regional Early Action Planning (REAP) grants for 2021. The funding will be used to reduce VMT, accelerate infill housing, and affirmatively further fair housing in all six of BCAG's member jurisdictions.

- Local Planning
  - General Plan Updates – The County of Butte recently completed a minor update of the general plan which included the new Upper Ridge Community Plan in Magalia. The City of Oroville has initiated an update of the General Plan which is expected to be completed over the next several years.
  - Annexations - Several areas of existing development adjacent and within the cities of Oroville and Chico have been annexed out of the County.
  - Housing Elements – Local jurisdictions are currently in the process of finalizing their 6th cycle housing elements.
  - Specific Plans – The City of Chico is preparing the Barber Yard Specific Plan for a proposed mixed-use development at the site of the former Diamond Match Company location within the city.
  - ADU's – Between 2019 and 2022 the region has issued 147 certificates of occupancy for accessory dwelling units, with 100+ of these units in the City of Chico.
  - Multi-Family Residential Development - Multi-family and affordable housing development has increased significantly in the past few years, especially in the Chico and Oroville areas.
  - Wildfire Recovery Efforts - The Town of Paradise has continued with its rebuilding efforts following the Camp Fire in 2018. They are currently seeing ~700 units of new housing per year over the past several years and expect this trend to continue. The town is also exploring sewer

[4] *Butte County Regional Travel Survey*, Butte County Association of Governments, June 2023 - https://www.bcag.org/documents/planning/RTP%20SCS/2024%20RTP%20SCS/SCS/BCAG_Travel_Survey_Report_Final_June_2023.pdf

service to the downtown and core areas which would allow increased densities.

Projected Revenues

Revenue estimates for the 2024 RTP/SCS update are currently being finalized. An early review of the data indicates the following:

- Many of the region’s revenues are addressing a backlog of safety and operational needs. Caltrans will continue to be a major partner in addressing operations and maintenance of the state highway system in Butte County.
- Bicycle and pedestrian projects are anticipated to maintain at a higher level than previous RTPs, as the area looks to utilize regional funds to leverage grant funding opportunities. The region has a history of success with the state Active Transportation Program.
- Capacity increasing projects are not projected to significantly increase in the RTP. Funds which typically contribute to capacity increasing types of projects are expected to continue to decline as the main revenue source (gas tax) is not keeping pace with VMT.
- BCAG anticipates pursuing increased mass-transit investments including passenger rail investments. This would be consistent with Governor Newsom’s executive order to reduce greenhouse gas emissions and the direction by CalSTA with the Climate Action Plan for Transportation Infrastructure (CAPTI).

CARB Recommendations

After completing the technical review of BCAG’s 2020 RTP/SCS, CARB provided several recommendations for BCAG’s consideration in developing the 2024 RTP/SCS.

1. *Recommendation* - Consider how planning assumptions and policy adjustments could best address the population and transportation impacts resulting from the 2018 Camp Fire.

   Action – In 2021, BCAG completed the Post Camp Fire Regional Population and Transportation Study to better understand the transportation related impacts from the fire and address the population, transit, and non-motorized updates which would be needed moving forward. The Study has provided the foundation for the regional growth forecasts, transit, and non-motorized improvements included in the 2024 RTP/SCS. The associated policy adjustments are provided in the 2024 RTP/SCS.

2. *Recommendation* - Planning assumptions and policy adjustments should respond to observed data.

   Action – BCAG has made additional efforts to collect observed data, with the development of the 2024 RTP/SCS, to inform the planning assumptions and policy adjustments. These efforts include the following: Butte County Regional Travel Survey (June 2023), Post Camp Fire Regional Population and Transportation Study (2021), B-Line Routing Study (July 2023), and Sustainable Communities Strategy Progress Report (July 2023). Each of these efforts have been noted and discussed in earlier sections of the document.

3. *Recommendation* - RTP/SCS investments should support the plan's mode shift strategies.

   Action – BCAG has reviewed the process for updating and reporting the financial components of the 2024 RTP/SCS to better address the recommendation. The project list included in the final submittal of the RTP/SCS to CARB includes the level of detailed required to support the mode shift strategies included in the plan.

4. *Recommendation* - Forecasted RTP/SCS travel trends should explain how the plan achieves GHG/VMT reductions.

   Action – Prior to submittal of the final data package to CARB, BCAG will complete a full review of the forecasted travel trends to confirm that they are directionally consistent with changes in GHG reductions. In the case a trend is not consistent, a sufficient explanation will be provided to support the reported metric.

REGIONAL GROWTH FORECASTS

In March 2023, BCAG prepared the Long-Term Regional Growth Forecasts 2022-2045 (Attachment B) The forecasts are an update of those developed for the 2021 Post Camp Fire Study.

Forecasts	2020 RTP (Year 2035)	2024 RTP (Year 2035)
Population	258,113	241,939
Household Population*	251,863	236,443
Households	103,545	101,118
Persons Per Household	2.43	2.34
Jobs	89,071	92,400
Jobs to Housing Unit Ratio	0.80	0.84

*Note: For modeling and meeting SB 375 targets, BCAG will be excluding group quarters from the population, as requested by ARB. CA Dept. of Finance estimates were utilized in determining the group quarter population for each analysis year.

In comparison to the regional forecast prepared by BCAG in 2019 for the 2020 RTP/SCS, the overall base year rates are down due to the loss of population following the 2018 Camp Fire and 2020 North Complex fires. In addition, the distribution of housing will be changed for the long-term. With the extensive loss of housing in the Paradise and Magalia areas, and the shift in population focused to Chico, the regional share of housing growth in Chico will increase compared with the 2020 RTP/SCS. The

Town of Paradise will see a period of elevated growth in the near term, and then begin to trend downward toward pre-fire growth rates by 2035.

The regional forecasts rely on California Department of Finance (DOF) data to establish base and forecast year estimates of population and housing at the regional level. Net migration and population growth are based on DOF forecasts. Household formation rates are determined utilizing DOF base year (2022) estimates at the jurisdiction level and remain constant over the forecast period (2022-2045). Employment estimates utilize base year information from California Employment Development Department (EDD) and are forecast using the methodology described in Attachment B.

As requested by ARB, BCAG has removed group quarters from the overall regional population totals and developed a household population estimate for calculating the CO_2 per capita metric. Household population estimates have been prepared for all future analysis years by applying the base year (2022) group quarters rate from the Department of Finance. The year 2005 rates were also pulled from existing Department of Finance data. Data for each analysis year has been provided in Attachment C.

The regional growth forecasts provide the control totals for use in BCAG's regional land use allocation model. Each jurisdiction receives an allocation of population and housing for each analysis year. Jobs are controlled at the regional level and have some flexibility when being allocated to jurisdictions. Typically, jobs are distributed based on the existing ratio of specific job segments to population.

BCAG adopted the 6th cycle Regional Housing Needs Plan (RHNP) in December 2020. The latest BCAG regional growth forecast is inclusive of this plan, as BCAG will be utilizing the medium scenario which has a total year 2035 capacity of 18,451 additional housing units, enough to meet the additional 15,506 units included in the RHNP. The 3,365 low or very low-income units identified in the RHNP will be carried over from the local jurisdiction's latest approved housing elements.

QUANTIFYING STRATEGIES

For the 2024 RTP/SCS, BCAG will be expanding on the strategies included in the previous SCS which focus on land use, housing, and alternative modes of transportation (transit, bike, and walk). In addition, BCAG will be including additional strategies such as micro-mobility, micro-transit, and workplace PHEV charging stations.

The table below contains the strategies and quantification methods which will be included as part of the 2024 RTP/SCS development process. Any strategies identified as part of scenario development, and noted as off-model, include the specific assumptions and methods used (Attachment D), once approved by ARB.

2024 RTP/SCS Strategy - Draft	Quantification Method
Land Use & Housing • redistribute future housing and employment among growth areas to increase diversity, density, and accessibility. • increased housing-mix	Travel Demand Model
Transit • increase fixed-route service in high demand areas • replace fixed-route service in low demand areas with micro-transit	Travel Demand Model
Active Transportation • increased bike and pedestrian network improvements	Travel Demand Model
Micro-mobility • E-bike incentives	Off-Model
Electric Vehicles • Plug-in Hybrid Electric Vehicle (PHEV) workplace charging stations	Off-Model

Interregional Travel

In preparing the GHG emissions analysis for 2024 RTP/SCS, BCAG will subtract all emissions from through trips (X-X trips). In addition, the portion of VMT from trips that either begin or end within the region but travel to/from neighboring regions (X-I, I-X trips) will be included for all portions of the trip within the BCAG region, this is consistent with the method used in preparing BCAG's recommendation to ARB for targets which were approved in 2010 and those applied to the 2012 RTP/SCS, as well as the method used for the 2016 and 2020 RTP/SCS and updated targets approved by ARB in 2018.

The percentage of VMT by through trip type (X-X) will be calculated for the 2035 target year.

Interregional trip distributions and purpose determinations will utilize data from the California household travel survey, Location-based Services (LBS)/Connected Vehicles (CV), and the California statewide travel model.

EMFAC

BCAG will utilize ARB's 2014 emissions factor model (EMFAC), as it did with the 2020 RTP/SCS. EMFAC will be used to calculate the carbon dioxide (CO2) emissions output based on the provided VMT and speed bin classification from the travel model. BCAG utilizes the annual option for CO2 output as suggested by the 2010 Regional Targets Advisory Committee report.

Once all vehicle trips are processed in EMFAC, BCAG extracts the total VMT and CO2 emissions for LDA, LDT1, LDT2, and MDV vehicle types. This ensures that only passenger vehicle (cars and light trucks) types are included in the emissions analysis.

BCAG will apply the prescribed adjustment included in *Methodology to Calculate CO2 Adjustment to EMFAC Output for SB 375*, provided by ARB, as modified by BCAG for the 2020 RTP/SCS (Attachment E). The prescribed adjustment is 4.81% for the year 2035.

LAND USE AND TRAVEL DEMAND MODELING

BCAG will be utilizing a land use allocation model and a travel demand forecasting model in preparing the 2024 RTP/SCS.

Land Use Allocation Model

In preparing the 2024 RTP/SCS, the land use allocation model base year will be updated to 2022, to coincide with the latest validated travel model and existing land use datasets. Land use allocations will then be developed for the years 2035 and 2045. The forecasted allocation years of 2035 and 2045 will be based on the preferred scenario identified through a public process.

BCAG has completed transitioning the model from UPlan to Community-Viz software platform. In addition, land use assumptions have been updated to reflect changes to local land use plans and existing uses.

A complete copy of the regional land use allocation model documentation is included as Attachment F.

Travel Demand Model

The BCAG Regional Travel Demand Model is a traditional four-step model and is used to forecast travel activity based on inputs of the forecasted allocation of housing and non-residential land uses from the land use allocation model and forecasts of the regional transportation network. Inputs will be prepared for the model base year (2022), the GHG target year of 2035, and the 2024 RTP horizon year of 2045.

The model is currently being updated for the 2024 RTP/SCS. Revisions to the model include the following:

New Features

- Traffic Analysis Zone (TAZ) System: Add more zonal detail in Chico and Oroville areas to reflect recent land use development projects.
- Trip Generation: Update to reflect post-pandemic trip rates and add new rate for on-campus college housing.

Updated Features

- Trip Distribution: Modify friction factors to better reflect shorter post-pandemic trip lengths.
- Interregional Travel: Re-estimate trip purpose splits for internal-external and external-internal travel.
- Through Travel: Values for trips traveling through the region will be updated for passenger vehicles and trucks.
- Multimodal Network: Update network to match new TAZ level of detail and modifications since last calibration. Transit network update to reflect 2022 service.
- Travel Cost: Update auto operating costs per ARB recommendations.
- Mode Choice: Update built environment inputs.
- Land Use Inputs: Update base year 2018 data to represent base year 2022. Update future forecasts to account for the Camp Fire, North Complex Fire, and revised housing, student, and job totals.
- Transportation Projects: The transportation project list was updated to reflect the currently planned and programmed projects.

As discussed with ARB, the previous induced vehicle travel tests confirmed the model's sensitivity to short-term effects. To represent long-term induced vehicle travel effects, the travel model documentation will explain the need for separate land use forecasts for no build and build scenarios or use of an off-model adjustment. The off-model adjustments includes a hybrid method for using the model and research-based elasticities. Option #3 of the induced travel demand off-model adjustment has been applied to the preferred scenario for the year 2035. Attachment G includes the induced travel demand off-model adjustment.

EXOGENOUS VARIABLES

Included in the table below are a listing of independent (exogenous) variables to be utilized in the model for scenario analysis.

Category	Variable Specification	Assumption (Year 2035)	Source
Demographics	Population, employment, and housing	Household Population = 236,443 Employment = 92,400 Households = 101,118	BCAG Long-Term Regional Growth Forecasts 2022-2045
Auto operating costs	Fuel and non-fuel related costs (maintenance, repair, and tire wear)	18.9 cents/mile	California Air Resources Board spreadsheet tool, 2020
Vehicle fleet efficiency	EMFAC 2014 model	Average passenger vehicle fuel economy 21 mpg	EMFAC 2014 default
Household income	Distribution	Baseline (2022)	BCAG Regional Travel Demand Model
Commercial vehicle activity	Share of commercial vehicle VMT	2.41%	BCAG Regional Travel Demand Model

Interregional travel	Share of external interregional VMT	2.08% of regional XX (external-external) VMT	BCAG Regional Travel Demand Model
Telecommute	Share of employees	5.6%-point increase from base year (18%)	Off-Model Calculation (Attachment D)
Telemedicine	Share of medical appointments	8%-point increase from base year (25%)	Off-Model Calculation (Attachment D)

As described earlier in the document, population, employment, and housing information was developed as part of BCAG's Long-Term Regional Growth Forecasts (2022-2045). At the request of ARB staff, group quarters populations have been removed for modeling purposes and are based on California Department of Finance (DOF) estimates for the year 2022 and carried forward at the same percentage for all subsequent analysis years.

Assumptions and data sources associated with auto operating costs, household income, commercial vehicle activity, and interregional travel have been detailed in the travel model documentation (Attachment H). Vehicle fleet efficiency for the region is presented as the EMFAC 2014 default for the BCAG region as it applies to passenger vehicles.

PRIOR RTP/SCS AND SCENARIO ANALYSIS

BCAG analyzed the 2020 RTP/SCS land use and transportation network as an additional scenario. Scenario development was used as a process to review strategies and determine a preferred scenario. A summary of the four different scenarios used in the process has been included in Attachment I. As such, the exogenous variables listed above were utilized as part of that analysis, except for the demographic category - as it applies to Scenario #1. Attachment J contains the draft results of the preferred scenario analysis.

It should be noted, BCAG is not subject to the incremental progress analysis included in ARB's (November 2019) evaluation guidelines, based on CARB staff recommendations outlined in the *Updated Final Staff Report: Proposed Update to the SB 375 Greenhouse Gas Emission Reduction Targets.*

UPDATES TO THIS DOCUMENT

As previously stated, this is intended to be a working document as BCAG and CARB coordinate on the technical aspects of quantifying the 2024 RTP/SCS.

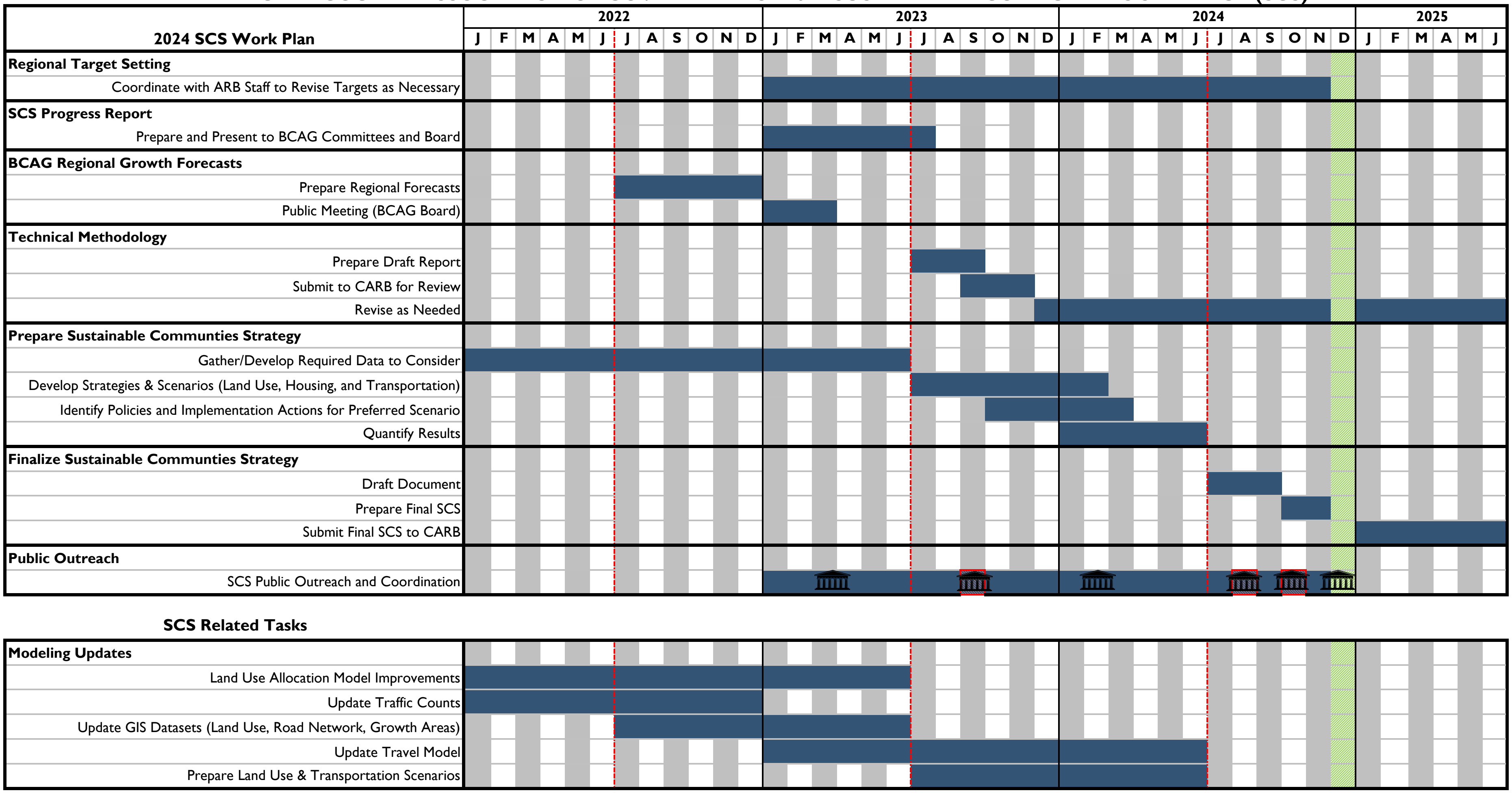
ATTACHMENT A

2024 RTP/SCS Schedule

See Next Page

ATTACHMENT A

BUTTE COUNTY ASSOCIATION OF GOVERNMENTS - 2024 SUSTAINABLE COMMUNITIES STRATEGY (SCS)



Date: August 2023

Board of Director's Meetings | Public Workshop / Hearing | Anticipated Adoption of 2024 RTP/SCS (Public Hearing)

ATTACHMENT B

Long-Term Regional Growth Forecasts 2022-2045

See Next Page

Long-Term
Regional Growth Forecasts
2022 – 2045

Prepared by:
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March 2023 (revised April 2024)

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This document is available online at www.bcag.org. Please direct any questions or comments to Mr. Brian Lasagna, BCAG Regional Analyst, by phone or email at blasagna@bcag.org.

TABLE OF CONTENTS

INDEX OF TABLES

APPENDICE

INTRODUCTION

Approximately every four years, the Butte County Association of Governments (BCAG) prepares long-term regional growth forecasts of housing, population, and employment for the Butte County area. Once prepared, the forecasts are utilized in developing BCAG's Regional Transportation Plan (RTP), Sustainable Communities Strategy (SCS), Air Quality Conformity Determination, and Regional Housing Needs Plan and provides data support for BCAG's regional Travel Demand Model. Local land use planning agencies may also elect to utilize the forecasts for preparing district plans or city and county long range plans.

As in the past, the forecasts have been developed by BCAG in consultation with its Planning Directors Group which consists of representatives from each of BCAG's local jurisdiction members and the Butte Local Agency Formation Commission. Each of the local jurisdictions provided valuable input regarding anticipated development and related growth within their respective planning areas.

A low, medium, and high scenario has been developed for each forecast of housing, population, and employment. The use of these scenarios provides for increased flexibility when utilizing the forecast for long-term planning and alleviates some of the uncertainty inherent in long range projections.

APPROACH

The growth forecasts presented in this document represent an update of the 2020-2045 Post Camp Fire Regional Growth Forecasts prepared in January 2021[1] and is intended to incorporate the latest estimates and projections from the State and impacts of the North Complex Fire. This update includes incorporation of the latest available California Department of Finance (DOF) population projections and estimates, and California Employment Development Department (EDD) job estimates. As presented, the forecasts meet both state and federal transportation planning requirements.

[1] Post Camp Fire Regional Growth Forecasts, January 2021. http://www.bcag.org/documents/Camp%20Fire/Post-Camp-Fire-Study-Appendix-A.pdf

REGIONAL FORECASTS

In comparison to the regional forecast prepared by BCAG in 2021, for the Post Camp Fire Study, the 2022 forecasts show a marginal change (-0.12%) in the population's compound annual growth for the period following the Camp Fire[2]. This change is based on new projections developed by DOF[3] and updated estimates of the current population.

One significant change, since the Post Camp Fire Study, is the decrease in base year population. The 2021 forecasts included a base year 2020 population of 210,291 persons. The latest DOF forecasts[4] estimate the year 2022 population of Butte County to be 201,608. This is likely due to several factors including the Camp Fire, North Complex Fire, and declining enrollment at California State University, Chico.

As observed in BCAG's past forecast, the City of Chico is expected to see the greatest growth in population and housing units, followed by the unincorporated areas of Butte County, the Town of Paradise, and City of Oroville.

Employment has fallen behind forecasts prepared in 2021 with a job to housing unit ratio of 0.84 achieved for 2022, compared to the 0.88 - 0.92 projected. However, the jobs rate has been increasing since the height of the COVID-19 pandemic.

[2] *The Post Camp Fire Study showed a compound annual growth rate of 1.05% for the 2020-2045 period.*

[3] *California Department of Finance. Demographic Research Unit. Report P-2A: Total Population Projections, California Counties, 2010-2060 (Baseline 2019 Population Projections; Vintage 2020 Release). Sacramento: California. July 2021.*

[4] *State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State — January 1, 2021-2022. Sacramento, California, May 2022.*

Table 1: Housing Forecasts 2022-2045

Low Scenario

Jurisdiction^	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045	Compound Annual Growth Rate (CAGR) 2022-2045
Biggs	677	690	730	775	789	798	121	18%	0.72%
Chico	45,793	46,948	49,371	51,880	52,590	53,096	7,303	16%	0.65%
Gridley	2,606	2,675	2,868	3,076	3,139	3,183	577	22%	0.87%
Oroville	7,783	7,889	8,211	8,561	8,668	8,743	960	12%	0.51%
Paradise	3,702	4,926	5,785	6,424	6,511	6,572	2,870	78%	2.53%
Unincorporated^^	30,988	31,688	33,296	34,989	35,478	35,827	4,839	16%	0.63%
Total County	91,549	94,816	100,261	105,705	107,173	108,220	16,671	18%	0.73%

Medium Scenario

Jurisdiction^	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045	Compound Annual Growth Rate (CAGR) 2022-2045
Biggs	677	694	746	805	823	835	158	23%	0.92%
Chico	45,793	47,299	50,457	53,726	54,652	55,311	9,518	21%	0.82%
Gridley	2,606	2,696	2,947	3,219	3,300	3,358	752	29%	1.11%
Oroville	7,783	7,921	8,340	8,798	8,936	9,034	1,251	16%	0.65%
Paradise	3,702	5,297	6,417	7,249	7,362	7,443	3,741	101%	3.08%
Unincorporated^^	30,988	31,900	33,996	36,202	36,840	37,295	6,307	20%	0.81%
Total County	91,549	95,807	102,903	110,000	111,913	113,277	21,728	24%	0.93%

High Scenario

Jurisdiction^	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045	Compound Annual Growth Rate (CAGR) 2022-2045
Biggs	677	698	763	836	858	873	196	29%	1.11%
Chico	45,793	47,664	51,588	55,651	56,801	57,620	11,827	26%	1.00%
Gridley	2,606	2,718	3,030	3,368	3,469	3,541	935	36%	1.34%
Oroville	7,783	7,954	8,475	9,044	9,215	9,338	1,555	20%	0.80%
Paradise	3,702	5,684	7,076	8,110	8,250	8,351	4,649	126%	3.60%
Unincorporated^^	30,988	32,122	34,725	37,467	38,260	38,825	7,837	25%	0.99%
Total County	91,549	96,840	105,658	114,476	116,853	118,548	26,999	29%	1.13%

** Source: State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, January 1, 2021-2022. Sacramento, California, May 2022.*

Notes:
^ Jurisdictional figures reflect anticipated new growth within the anticipated boundaries of each jurisdiction and do not reflect future annexation of existing units or as-yet-unbuilt new units in unincorporated areas to the respective cities. Assumptions about future boundaries are not intended by BCAG to be interpreted as factors limiting such jurisdictions' future boundaries.

^^ Unincorporated Butte County figures exclude forecasted growth identified in the Butte County General Plan 2030 - Environmental Impact Report as Doe Mill/Honey Run Specific Plan, Thermolito Afterbay, Biggs Area, and Gridley Area.

Table 2: Population Forecasts 2022-2045

Low Scenario

Jurisdiction^	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045	Compound Annual Growth Rate (CAGR) 2022-2045
Biggs	1,939	1,976	2,091	2,220	2,259	2,286	347	18%	0.72%
Chico	102,892	105,488	110,932	116,569	118,164	119,301	16,409	16%	0.65%
Gridley	7,205	7,396	7,928	8,506	8,678	8,801	1,596	22%	0.87%
Oroville	18,863	19,119	19,899	20,750	21,007	21,190	2,327	12%	0.51%
Paradise	7,705	10,252	12,041	13,370	13,550	13,679	5,974	78%	2.53%
Unincorporated^^	63,004	64,427	67,696	71,138	72,133	72,843	9,839	16%	0.63%
Total County	201,608	208,658	220,588	232,552	235,790	238,099	36,491	18%	0.73%

Medium Scenario

Jurisdiction^	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045	Compound Annual Growth Rate (CAGR) 2022-2045
Biggs	1,939	1,988	2,137	2,306	2,356	2,392	453	23%	0.92%
Chico	102,892	106,276	113,371	120,717	122,796	124,278	21,386	21%	0.82%
Gridley	7,205	7,454	8,148	8,900	9,124	9,285	2,080	29%	1.11%
Oroville	18,863	19,196	20,214	21,322	21,657	21,896	3,033	16%	0.65%
Paradise	7,705	11,024	13,356	15,088	15,324	15,491	7,786	101%	3.08%
Unincorporated^^	63,004	64,859	69,119	73,605	74,903	75,827	12,823	20%	0.81%
Total County	201,608	210,797	226,345	241,939	246,160	249,169	47,561	24%	0.93%

High Scenario

Jurisdiction^	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045	Compound Annual Growth Rate (CAGR) 2022-2045
Biggs	1,939	2,000	2,185	2,395	2,457	2,501	562	29%	1.11%
Chico	102,892	107,097	115,913	125,041	127,625	129,466	26,574	26%	1.00%
Gridley	7,205	7,514	8,376	9,312	9,590	9,789	2,584	36%	1.34%
Oroville	18,863	19,277	20,541	21,919	22,335	22,632	3,769	20%	0.80%
Paradise	7,705	11,830	14,727	16,879	17,172	17,380	9,675	126%	3.60%
Unincorporated^^	63,004	65,309	70,603	76,177	77,789	78,938	15,934	25%	0.99%
Total County	201,608	213,026	232,346	251,723	256,967	260,707	59,099	29%	1.12%

** Source: State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, January 1, 2021-2022. Sacramento, California, May 2022.*

Notes:
^Jurisdictional figures reflect anticipated new growth within the anticipated boundaries of each jurisdiction and do not reflect future annexation of existing units or as-yet-unbuilt new units in unincorporated areas to the respective cities. Assumptions about future boundaries are not intended by BCAG to be interpreted as factors limiting such jurisdictions' future boundaries.

^^ Unincorporated Butte County figures exclude forecasted growth identified in the Butte County General Plan 2030 - Environmental Impact Report as Doe Mill/Honey Run Specific Plan, Thermolito Afterbay, Biggs Area, and Gridley Area.

Table 3: Employment Forecasts 2022-2045

Low Scenario

Jurisdiction	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045
Butte County	77,000	81,542	86,224	88,793	88,954	88,740	11,740	15%

Medium Scenario

Jurisdiction	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045
Butte County	77,000	82,394	88,497	92,400	92,888	92,887	15,887	21%

High Scenario

Jurisdiction	2022*	2025	2030	2035	2040	2045	Total Increase 2022-2045	Percent Increase 2022-2045
Butte County	77,000	83,282	90,866	96,160	96,988	97,209	20,209	26%

Table 4: Jobs (Non-Farm) to Housing Unit Ratios 2022-2045

Factor	2022*	2025	2030	2035	2040	2045
Jobs/Housing Unit	0.84	0.86	0.86	0.84	0.83	0.82

** Source: State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, January 1, 2021-2022. Sacramento, California, May 2022. California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA).*

FORECAST METHODOLOGY

BCAG has prepared the forecasts using professionally accepted methodologies for long-range forecasting. Long-term projections prepared by the DOF were consulted for Butte County and used to re-establish control totals for the region. Additionally, new base year information was incorporated from the latest available DOF estimates[5]. As an update of the projections prepared for the Post Camp Fire Study, the share of regional growth was carried over to maintain each jurisdiction's portion of allocated growth. The allocation of growth into five-year increments has been maintained along with the horizon year of 2045. Lastly, low, medium, and high scenarios were prepared for each forecasted category.

HOUSING

The latest DOF long range projections[6], as of July 2021, were analyzed for the period 2022-2045 for the Butte County region. These population projections estimate that the Butte County region will add ~21,700 new housing units over the next 23 years, when utilized with the persons per housing unit information in Appendix A. This information was used to establish the control total for BCAG's medium forecast scenario.

BCAG then prepared an update of the 2020-2045 Post Camp Fire Study growth forecasts utilizing updated 2022 base line data and the long-range forecasts from DOF. Housing units were then allocated at the jurisdictional level based on each jurisdiction's share of regional growth contained in the 2020-2045 forecasts for each 5-year growth period. Appendix A provides the assumptions utilized in preparing the housing forecasts.

Based on a 0.2 percent incremental change of the medium scenarios compound annual growth rate (CAGR), a low and high housing scenario were developed using a CAGR of 0.73% and 1.13%. This incremental change is identical to that included with the 2014 and 2018 forecasts. No additional scenarios were included with the Post Camp Fire Study.

POPULATION

Population forecasts were prepared by applying the 2022 average persons per housing unit to the housing unit forecasts. This method allows for the capture of variations in household size for each jurisdiction. Unlike past regional growth forecasts, the persons per housing unit was maintained throughout each forecast year. Recent figures published by DOF show that person per housing unit numbers have varied greatly in the period following the Camp Fire.

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[5] *State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, January 1, 2021-2022. Sacramento, California, May 2022. California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA).*

[6] *California Department of Finance. Demographic Research Unit. Report P-2A: Total Population Projections, California Counties, 2010-2060 (Baseline 2019 Population Projections; Vintage 2020 Release). Sacramento: California. July 2021.*

EMPLOYMENT

Employment forecasts were prepared at the regional/county level only and are based on a ratio of jobs per housing unit.

Base year 2022 and historical employment data was obtained from the California Employment Development Department (EDD) for the years 2013-2022. The EDD data provides an annual average total of all non-farm jobs for the region. This information was then used in conjunction with DOF housing unit estimates to calculate a ratio of 0.84 jobs per housing unit for the year 2022 and a ratio of 0.82 10-year (2013-2022) historical average.

The 10-year historical ratio was applied to the year 2045 based on the long-term historical average. The years 2025 (0.86) and 2030 (0.86) show a minimal rise in the jobs rate which coincides with the increased housing production and population increases for those periods. The years 2035 (0.84), 2040 (0.83), and 2045 (0.82) represent a linear reduction to the historical average.

Lastly, the jobs to housing unit ratio developed for each 5-year period was applied to all scenarios.

Appendix A

Housing Assumptions

Share of Regional Growth by 5-Year Period

Jurisdiction	Share of Regional Growth (SRG) 2022-2025	Share of Regional Growth (SRG) 2025-2030	Share of Regional Growth (SRG) 2030-2035	Share of Regional Growth (SRG) 2035-2040	Share of Regional Growth (SRG) 2040-2045
Biggs	0.4%	0.7%	0.8%	0.9%	0.9%
Chico	35.4%	44.5%	46.1%	48.4%	48.3%
Gridley	2.1%	3.5%	3.8%	4.2%	4.3%
Oroville	3.2%	5.9%	6.4%	7.2%	7.2%
Paradise	37.5%	15.8%	11.7%	5.9%	5.9%
Unincorporated	21.4%	29.5%	31.1%	33.3%	33.3%
Total County	100.0%	100.0%	100.0%	100.0%	100.0%

Population Assumptions

Persons Per Housing Unit by Year

Jurisdiction	2022 (DOF)	2025	2030	2035	2040	2045
Biggs	2.86	2.86	2.86	2.86	2.86	2.86
Chico	2.25	2.25	2.25	2.25	2.25	2.25
Gridley	2.76	2.76	2.76	2.76	2.76	2.76
Oroville	2.42	2.42	2.42	2.42	2.42	2.42
Paradise	2.08	2.08	2.08	2.08	2.08	2.08
Unincorporated	2.03	2.03	2.03	2.03	2.03	2.03
Total County	2.20	2.20	2.20	2.20	2.20	2.20

2022 Source: State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, January 1, 2021-2022. Sacramento, California, May 2022. California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA).

Note: Unlike past regional growth forecasts, the persons per housing unit was maintained throughout each forecast year. Recent figures published by DOF show that person per housing unit numbers have varied greatly in the period following the Camp Fire.

Countywide Population Forecast Comparison to DOF Estimates

	A	B	C
Year	DOF	BCAG (Scenario A)	Meets State Requirement
2025	230,691	210,797	NO
2030	236,874	226,345	NO
2035	242,240	241,939	YES
2040	246,453	246,160	YES
2045	249,457	249,169	YES

A. California Department of Finance. Demographic Research Unit. Report P-2A: Total Population Projections, California Counties, 2010-2060 (Baseline 2019 Population Projections; Vintage 2020 Release). Sacramento: California. July 2021.

Report P-2A: Total Estimated and Projected Population for California and Counties: July 1, 2010 to 2060

	Projections									
Geography	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**	**2045**	**2060**
California	39,953,269	40,146,003	40,354,217	40,574,215	40,808,001	41,860,549	42,718,403	43,353,414	43,785,947	44,228,057
Butte County	226,910	227,736	228,623	229,680	230,691	236,874	242,240	246,453	249,457	258,144

Projections Prepared by Demographic Research Unit, California Department of Finance, July 2021

B. BCAG Provisional Long-Term Regional Growth Forecasts 2022-2045 (Medium Scenario)
C. California regulations (CA Code §65584.01) require that population forecasts used in preparing the RTP/SCS must be within +/- 1.5% of DOF numbers.

Employment Assumptions

Historical Jobs to Housing Unit Ratios

Factor	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10 - Year Average
Jobs (Total Nonfarm) ^	74,100	76,000	77,900	79,800	81,500	82,500	80,600	73,800	75,200	77,000	
Housing Units ^^	96,884	97,379	97,772	98,263	98,871	99,353	85,447	90,133	90,021	91,549	
Jobs Per Housing Unit	0.76	0.78	0.80	0.81	0.82	0.83	0.94	0.82	0.84	0.84	**0.82**

Source:
^California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA)
^^California Department of Finance E-5 City/County/State Population and Housing Estimates

ATTACHMENT C

Estimates and Forecasts for 2024 SCS Analysis Years

Analysis Years	2005	2022	2035	2045
Population	214,582[1]	201,608[2]	241,939	249,169
Household Population	208,322[1]	197,020[2]	236,443	243,499
Housing Units	91,666[1]	91,549[2]	110,000	113,277
Households	85,478[1]	84,157[2]	101,118	104,131
Persons Per Household	2.44[1]	2.34[2]	2.34	2.34
Jobs	73,400[3]	77,000[3]	92,400	92,887
Jobs to Housing Unit Ratio	0.80	0.84	0.84	0.82

Sources:
[1] State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010
[2] State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State — January 1, 2021-2022. Sacramento, California, May 2022
[3] California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA)

ATTACHMENT D

BCAG Off-Model Calculations

See Next Page

BCAG Off-Model Calculations

Off-Model Calculation #1: Workplace EV Charger Incentive Program

Description: This strategy reduces CO2 emissions by providing funding incentives for 100 new workplace electric vehicle (EV) chargers. This will increase the number of workplace EV chargers in the region to facilitate workplace charging by plug-in hybrid electric vehicles (PHEVs)[1]. Currently, the average all-electric range (AER) of the PHEV fleet in California is approximately 33 miles per day per vehicle, while the average in-situ PHEV electric-drive range for this fleet usage is only 20 electric vehicle miles traveled (eVMT) per day per vehicle[2]. Charging at work can provide up to 13 additional eVMT per commute, reducing GHGs in the region. This strategy goes above and beyond state efforts to increase EV use by providing funding for 100 new workplace EV chargers and specifically targeting PHEV drivers. The current BCAG travel demand model does not differentiate between different light-duty vehicle types (i.e., gasoline, diesel, electric, PHEV), therefore this strategy cannot be modeled by the BCAG travel demand model, necessitating off-model calculations.

Objectives: Increase the number of eVMT and decrease the number of carbon vehicle miles traveled (cVMT) by PHEV drivers in the region to reduce GHG emissions.

Trip and Emissions Data Needs:

Funding/Incentives: Funding incentives in the amount of $5,000 each for 100 new workplace chargers will be developed. To implement this strategy, $500,000 in funding has been identified to offset employer costs and encourage strategy implementation. BCAG will be the lead agency for the program and intends to utilize both Transportation Development Act (TDA) and Congestion Mitigation and Air Quality (CMAQ) funds. Specific fund details will be included in the 2024 RTP/SCS.

Current Level of Deployment: This is a new strategy that will be deployed in the region to large employers, especially those located the greatest distance from housing.

Future Level of Deployment: Through this new strategy, future deployment is expected to result in 5 new workplace chargers at 20 separate employment locations. The strategy goes beyond existing state programs to implement EV chargers. Strategy implementation will begin following SCS approval and will be tracked to ensure 100 new chargers are implemented in area workplaces by 2035.

Responsible Parties: BCAG will work with area employers and Butte County Air Quality Management District (BCAQMD) to implement the strategy. BCAG will track strategy implementation and metrics.

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[1] PHEVs, in general, have an option to operate in gasoline or electric mode, unlike battery electric vehicles (BEVs). As such, the goal of the strategy is to facilitate PHEV workplace charging and is not intended to capture BEVs.

[2] California Air Resources Board 2017. Unpublished data and California Air Resources Board. California's Advanced Clean Cars Midterm Review: Summary Report for the Technical Analysis of Light Duty Vehicle Standards. Appendix G. Table 14. January 2017. Available at: https://www.arb.ca.gov/msprog/acc/mtr/acc_mtr_finalreport_full.pdf.

Affected Population: The population being targeted by the strategy includes area commuters, particularly those with longer trip lengths, and larger employers including those located in or adjacent to disadvantaged communities.

Trip and Emissions Data:

- # of new workplace EV charging stations = 100
- # of vehicles charged per EV charging station = 7
- # of PHEVs participating in the program = 700
- # of EV charging facilities implemented as part of program = ~20
- Electric range or PHEVs in the region = assume state average of 20
- Average PHEV trip length = assume state average or 33
- Amount of CO2 avoided per PHEV eVMT = 198 grams
- Conversion rate of grams to pounds = 0.00220462

Quantification Methodology:

Off-Model PHEV Workplace Charging Stations Methodology (CARB - Method a)

Step #	Variable	Data Source	Year 2035
Step 1	# of new workplace EV chargers	BCAG	100
Step 2	# of PHEVs per charger	CARB default (NREL)[1]	7
Step 3	# of PHEVs in region using new chargers	Step 1 x Step 2	700
Step 4	eVMT increase per PHEV	CARB default	13
Step 5	Total increase in PHEV eVMT	Step 3 x Step 4	9,100
Step 6	CO2 avoided per PHEV eVMT (grams)	CARB default[2]	198
Step 7	Displaced CO2 emissions (lbs)	(Step 5 x Step 6)*0.00220462[3]	3,972.28
Step 8	Displaced CO2 emissions (tons)	Step 7 / 2000	1.99

Source:

[1] Melaina Marc, Michael Helwig. 2014. California Statewide Plug-In Electric Vehicle Infrastructure Assessment. Page 21. Figure 8. Final Report of National Renewable Energy Laboratory to California Energy Commission under Agreement 600-11-002. California Energy Commission, Sacramento, CA. Publication Number: CEC-600-2014-003. Available at: https://www.nrel.gov/docs/fy15osti/60729.pdf

[2] CARB. 2017 Unpublished. Internal CARB analysis of Southern California vehicle trip data indicating that workplace EV charging connectors would increase average PHEV e-miles by 13 e-miles per day per PHEV from 20 e-miles per day per PHEV to the 2016 State-average all-electric range for PHEVs of 33 miles per day.

[3] Converstion rate for grams to lbs (0.00220462)

Challenges, Constraints, and Strategy Implementation Tracking: Area employers may not be receptive to installing EV chargers, even with the $5,000 funding incentive. If employer receptiveness is not sufficient, BCAG will explore alternative options such as increasing the funding incentive per employer, conducting employer/employee educational meetings with BCAQMD, and possibly increasing the total funding amount. BCAG will track the number of EV chargers installed as a metric to determine the success of implementation.

Off-Model Calculation #2: E-Bike Incentive Program

Description: This strategy reduces CO_2 emissions by providing funding incentives for 500 new e-bikes. E-bike incentive programs have shown significant potential in reducing GHG emissions by encouraging mode shift from auto use to e-bike. Research shows that e-bikes are used to a greater extent than conventional bicycles with users routinely traveling farther and being able to replace auto trips.

This strategy provides funding incentives for 500 new e-bikes in the region. Conventional bike trips are forecasted in the BCAG travel demand model mode choice step, but the estimation of this sub-model was based on conventional bicycle use. E-bikes, as noted above, substitute for driving at greater rates and for longer distances. Additionally, the potential for the incentive program to increase the proportion of bicycle users is not accounted for in the model, necessitating off-model calculations for this unique mode.

Objectives: The off-model strategy would reduce CO_2 emissions by replacing vehicle trips with e-bike trips, thus decreasing VMT.

E-bike incentive strategy can potentially reduce GHG emissions by:

- Replacing or reducing vehicle trips with E-bike trips
- Encouraging broader range of adoption of cycling, including people that may not be physically fit and low-income population who cannot afford E-bike initially
- Promoting long-term changes in mode choice which lead to sustained reductions in GHG emissions

Trip and Emissions Data Needs:

Funding/Incentives: Funding incentives in the amount of $500 each for 500 new e-bikes will be developed. To implement this strategy, $250,000 in funding has been identified to offset e-bike costs and encourage strategy implementation. BCAG will be the lead agency for the program and intends to utilize both Transportation Development Act (TDA) and Congestion Mitigation and Air Quality (CMAQ) funds. Specific fund details will be included in the 2024 RTP/SCS.

Current Level of Deployment: California Air Resources Board (CARB) is currently deploying a similar program statewide. CARB's program is targeting incentives of $1,750 to specific low-income individuals. Specific amounts allocated to regions are not yet available. BCAG's program is expected to be supplemental to CARB's program.

Future Level of Deployment: Through BCAG's strategy, future deployment is expected to result in the addition of 500 new e-bikes in the region. The strategy goes beyond existing state programs to implement e-bikes. Strategy implementation will begin following SCS approval and will be tracked to ensure 500 new e-bikes are purchased in the region by 2035.

Responsible Parties: BCAG will work with Chico Velo to implement the strategy. BCAG will track strategy implementation based on the number of e-bikes purchased.

<u>Affected Population:</u> BCAG will target areas in the region with robust active transportation networks to facilitate e-bike utilization and target locations in or adjacent to disadvantaged communities.

<u>Trip and Emissions Data:</u>

- # of new E-Bike incentives = 500
- Weekday VMT decrease per E-Bike = 2.325 miles

Quantification Methodology:

GHG emission reductions from e-bike incentive strategies are a result of VMT reductions due to mode shift from vehicle trips to e-bike trips. The following steps present a VMT reduction-based approach for forecasting GHG emission reductions associated with e-bike incentive strategies.

Step 1: Confirm the funding incentive ($500 per e-bike) and the number of participants (up to 500) in the region.

Step 2: Determine the relationship between e-bike incentives, increased e-bike trips, and decreased private automobile trips/VMT.

Due to the lack of local surveys in the BCAG region, relevant studies on e-bike incentive programs have been reviewed. The conclusions, documenting the impact of e-bike incentives on mode shift and potential VMT changes, are summarized in the table below.

Study	Study Area	Model shift and VMT change
Bigazzi, Hassanpour, and Bardutz (2024)[3]	Greater Victoria region, Canada	Auto use reduced by 49 km (30.45 miles) per week a year after purchase.
Sundfør and Fyhri (2022)[4]	Oslo, Norway	E-bike incentivized purchasers increased the distance per trip of e-bike use by 4.8 km (3 miles), and decreased automobile use by 1.2 km (0.75 miles).
Johnson, Fitch-Polse, and Handy (2023)[5]	Rebate programs offered by the Redwood Coast Energy Authority (RCEA), Peninsula Clean Energy (PCE), and Contra Costa County (CC)	E-bike incentive recipients reduced GHG emission of 12 to 44 kg CO2 per month.

[3] Bigazzi, A., Hassanpour, A., & Bardutz, E. (2024). Travel behavior and greenhouse gas impacts of the Saanich e-bike incentive program. District of Saanich, 48.
[4] Sundfør, H. B., & Fyhri, A. (2022). The effects of a subvention scheme for e-bikes on mode share and active mobility. Journal of Transport & Health, 26, 101403.
[5] Johnson, N., Fitch-Polse, D. T., & Handy, S. L. (2023). Impacts of e-bike ownership on travel behavior: Evidence from three northern California rebate programs. Transport policy, 140, 163-174.

Shankari, Boyce, Hintz, and Duvall (2021)[6]	Colorado State	E-bike trips primarily replaced single-occupancy vehicle (SOV) trips by 28%.

Although some studies (Johnson et al., 2023; Sundfør and Fyhri, 2022) indicate that e-bike usage has a greater impact on recreational trips, there is no evidence suggesting that e-bike incentive programs do not also reduce other types of vehicle trips. Furthermore, evidence shows that e-bike incentive programs significantly reduce the average automobile trip length, particularly for low-income populations (Bigazzi et al., 2024). However, reductions in VMT and shifts in mode choice are observed across all income groups.

Step 3: Estimate the average daily vehicle trip rate per person in the BCAG region.

Based on the BCAG travel demand model for the 2022 base year, the average daily vehicle trip rate per person is 3.1.

Step 4: Calculate the total VMT reduction.

Using Bigazzi's study, the average daily VMT reduction is 4.35 miles per user benefiting from the e-bike incentive program. Based on Sundfør's study and the average trip rate estimated in Step 3, the average daily VMT reduction is 2.325 miles.

Considering the above discussion, the VMT reduction per e-bike is assumed to be 2.325 miles per day per participant, which is still lower than the results from Bigazzi's study.

Step 5 and Step 6: Calculate the total CO2 emissions reduction using 2021 EMFAC emissions inventory.

Off-Model E-bike Incentivies Methodology

Step #	Variable	Data Source	2035
Step 1	Number of participants in the region	BCAG model	500
Step 2	Average automobile trip length reduction	Research[1]	0.75
Step 3	Average daily vehicle trip rate per person	BCAG model	3.10
Step 4	Displaced VMT	Step 1 x Step 2 x Step 3	1,163
Step 5	Displaced private auto CO_2 emissons rate	EMFAC 2021[2]	0.000281764
Step 6	Displaced CO_2 emissions (tons)	Step 4 x Step 5	0.32755065

Source:

[1] Sundfør, H. B., & Fyhri, A. (2022). The effects of a subvention scheme for e-bikes on mode share and active mobility. Journal of Transport & Health, 26, 101403.

[2] EMFAC2021 (v1.0.2) Emissions Inventory, BCAG Region, Year 2035, Season Annual, Total VMT = 6047689.201, Total CO2 = 1704.023793 (tons). Total CO2/Total VMT = 0.000281764 (tons).

[6] Shankari, K., Boyce, L., Hintz, E., & Duvall, A. (2021). The CanBikeCO Mini Pilot: Preliminary Results and Lessons Learned (No. NREL/TP-5400-79657). National Renewable Energy Lab. (NREL), Golden, CO (United States).

Challenges, Constraints, and Strategy Implementation Tracking: Area residents may not be receptive to purchasing e-bikes, even with the $500 funding incentive. If area residents' receptiveness is not sufficient, BCAG will explore alternative options such as increasing the funding incentive per resident, conducting bicycle educational meetings with Chico Velo, and possibly increasing the total funding amount. Strategy implementation will begin following SCS approval and will be tracked to ensure 500 new e-bikes are purchased in the region by 2035.

Off-Model Calculation #3: Telecommute

Description: This exogenous factor reduces CO_2 emissions by realizing a 5.6%-point increase (12.4% to 18%) in telecommuting in the region. Telecommuting is expected to increase in the region through 2035, reducing VMT and CO_2 emissions by decreased work related trips. Broadband continues to expand in the region due to various efforts including the Northeastern and Upstate California Connect Consortia, which are focused on improving broadband availability and performance within the region, particularly the rural eastern portions where cellular and broadband service is inadequate. Additionally, Starlink satellite-based Wi-Fi internet will continue to expand in the rural eastern portions of the region providing new opportunities for telecommuting. These efforts along with others will make telecommuting available to more residents in the region, reducing work related trips, VMT, and CO_2 emissions.

The current BCAG travel demand model is calibrated to the base year of 2022, which incorporates the local trip rates associated with different job categories and is validated based on observed data, therefore capturing existing levels of telecommuting. However, future year scenarios are developed based on land use changes and network improvements in the region with minor adjustments to trip rates to balance productions and attractions. No additional refinements were made to capture the increase in telecommuting. Thus, an off-model adjustment must be used at this time

Objectives: This exogenous factor would reduce CO_2 emissions by reducing work related trips and VMT through an expected 5.6%-point increase (12.4% to 18%) in telecommuting in the region due in part to expanded broadband and Starlink satellite utilization in the region. Cellular and broadband services are inadequate in the eastern portions of the region, which are expected to see expanded utilization of both broadband and Starlink satellite Wi-Fi services.

Trip and Emissions Data Needs:

Funding/Incentives: Funding is not identified. This exogenous factor is expected to result in the 5.6%-point increase. BCAG staff will continue to coordinate with the Northeastern and Upstate California Connect Consortia to facilitate broadband expansion in the region.

Current Level of Deployment: According to the 2022 1-year American Community Survey – Means of Transportation to Work (table K200801), 12.4% of workers were estimated to work from home. When applied to BCAG's year 2022 estimated 77,000 jobs in the region, this would amount to a year 2022 baseline of 9,582 employees working from home.

ACS (1 year) - Means of Transportation to Work (K200801)	Year 2022
Car, truck, or van - drove alone	73.7%
Car, truck, or van - carpooled	8.2%
Public transportation (excluding taxicab)	0.5%
Taxicab, motorcycle, bicycle, walked, or other means	5.2%
Worked from home	12.4%
Total	100.0%

Future Level of Deployment: This exogenous factor assumes telecommuting will increase from 12.4% (2022) to 18% (2035). This assumption is based on a review of the Butte County work from home rate during the spring and fall of 2021, which corresponds with the COVID-19 pandemic. During that period, the work from home rate reached a high of 32.1% in the Spring of 2021 according to Replica data which has been normalized by employment status. When the spring and fall seasons are averaged for the year 2021, a rate of 23.7% is realized. BCAG therefore makes a more conservative assumption that the telecommuting rate will rise again and stabilize, but using an assumed rate of 18%, which is less than the average rate of year 2021. When applied to the year 2035 estimated 92,400 jobs in the region, this would amount to 16,632 employees working from home.

Butte County Work From Home Percentage			
Year	Season	Work From Home*	**Normalized by Employment Status****
2021	Spring	13.70%	**32.10%**
2021	Fall	6.50%	**15.30%**
*"Work From Home" column: work from home percentage when Butte County is set as the home location.			
**"Normalized by Employment Status" column: Only employed residents are accounted when estimating WFH percentage.			
Data Source: Replica - based on megaregion model run on 9/2/2023			

Responsible Parties: BCAG will track implementation and metrics utilizing the U.S. Census Bureau – American Community Survey 1-year data.

Affected Population: The target population in Butte County for telecommuting is the office and public/quasi-public jobs sectors as allocated by the land use model. The office and public/quasi-public jobs sectors accounted for 23,878 jobs in the region in 2022. These sectors are expected to increase to 30,575 total jobs by 2035, according to *BCAG's Technical Methodology for Preparing 2024 Regional Transportation Plan / Sustainable Communities Strategy Land Use Allocations, July 2024 (table 4)*.

Trip and Emissions Data:

- Average number of telecommuting day(s) per worker or telecommuter for base and future analysis years = 1.85 for both 2022 and 2035
- Occupational classifications in the region that can participate in a telecommuting program = Office and Public/Quasi-Public
- Number of jobs in the region = 77,000 (2022) and 92,400 (2035)
- Average travel distance for home-based work (HBW) trips in the region = 13.4 miles
- Average travel distance for home-based other (HBO) trips in the region = 6.76 miles
- Baseline employees enrolled = 12.4%

- Forecasted employees enrolled = 18%

Quantification Methodology:

Off-Model Telecommuting Methodology				
Step #	**Variable**	**Data Source**	**2022 (Baseline)**	**2035**
Step 1	Jobs (Non-Farm)	BCAG model	77,000	92,400
Step 2	Average HBW trip length (miles)	BCAG model		13.4
Step 3	Average HBO trip length (miles)	BCAG model		6.76
Step 4	Average # of telecommute days per week	CARB[1]		1.85
Step 5	Baseline employees enrolled	American Community Survey[2] (12.4%)	9,582	11,498
Step 6	Additional employees enrolled	BCAG (92,400 jobs x 18%) - (92,400 jobs x 12.4%)		5,134
Step 7	Telecommuters per day	(Step 4 / 5 workdays) x Step 6		1,899
Step 8	Reduced trips per commuter (x2)	Step 7 (x2)		3,799
Step 9	Rebound effect	Step 3 x Step 8		25,680
Step 10	Total reduced VMT	(Step 2 x Step 8) - Step 9		25,224
Step 11	Displaced private auto CO_2 emissons rate	EMFAC 2021[3]		0.000281764
Step 12	Displaced CO2 emissions (tons)	Step 10 x Step 11		7.107252593

Source:

[1] Handy, S., Tal, G., & Boarnet, M. Policy Brief on the Impacts of Telecommuting Based on a Review of the Empirical Literature. December 2013. Available at: https://www.arb.ca.gov/cc/sb375/policies/telecommuting/telecommuting_brief120313.pdf. (1.2 + 2.5)/2 = 1.85

[2] U.S. Census Bureau. 1-year American Community Survey for 2022 (table K200801).

[3] EMFAC2021 (v1.0.2) Emissions Inventory, BCAG Region, Year 2035, Season Annual, Total VMT = 6047689.201, Total CO2 = 1704.023793 (tons), Total CO2/Total VMT = 0.000281764 (tons)

Challenges, Constraints, and Strategy Implementation Tracking: The rebound effect associated with telecommuting is still being researched and the overall VMT reductions are evolving. For preparing the methodology, BCAG assumes a rebound of 1 additional home-based other (HBO) trip for each home-base work (HBW) trip shifting to telecommuting. As research on telecommuting progresses, adjustments to the methodology may need to be revised. BCAG staff will track U.S. Census American Community Survey (ACS) data to determine the percentage increase in telecommuting in the region.

<u>Off-Model Calculation #4: Telemedicine</u>

Description: This exogenous factor reduces CO2 emissions by realizing an 8%-point increase (17% to 25%) in telemedicine in the region. Telemedicine is expected to increase in the region through 2035, due to an aging population and growing use of digital office visits, reducing vehicle trips and VMT. Broadband continues to expand in the region due to various efforts including the Northeastern and Upstate California Connect Consortia, which are focused on improving broadband availability and performance within the region, particularly the rural eastern portions where cellular and broadband service is inadequate. Additionally, Starlink satellite-based Wi-Fi internet will continue to expand in the rural eastern portions of the region providing new opportunities for telemedicine. These efforts along with others will make telemedicine available to more residents in the region, reducing vehicle trips and VMT.

The base year (2022) BCAG travel demand model has been calibrated and validated using observed data, including big data to understand travel patterns and collected traffic counts to evaluate roadway volume estimates. As a result, the current impact of telemedicine has already been captured in the base year model. However, future year scenarios are developed based on land use changes and network improvements in the region, without additional information on how the increase in telemedicine services might affect travel behavior. To account for potential increases in telemedicine, an off-model adjustment must be applied at this time.

Objectives: This exogenous factor would reduce CO2 emissions by reducing vehicle trips and VMT through an expected 8%-point increase (17% to 25%) in telemedicine in the region due in part to an aging population, efforts to reduce health care costs, and expanded broadband and Starlink satellite utilization in the region. Cellular and broadband services are inadequate in the eastern portions of the region, which are expected to see expanded utilization of both broadband and Starlink satellite Wi-Fi services.

Trip and Emissions Data Needs:

Funding/Incentives: Funding is not identified. Exogenous factors are expected to result in the 8%-point increase. BCAG staff will continue to coordinate with the Northeastern and Upstate California Connect Consortia to facilitate broadband expansion in the region.

Current Level of Deployment: Current telemedicine rates for the region are estimated at 17% based on two studies. The first of these studies estimates that telehealth visits represented "17% of total 2022 healthcare visits, a substantially larger share than the 2019, [pre-pandemic level] of less than 1%, but down from the high of 25% during the height of the pandemic in 2020."[7] The second referenced study concluded that, "as of 2021, overall telehealth use has stabilized at 38 times higher than before COVID-19 hit, ranging from 13% to 17% of visits across all specialties and remaining steady since June 2020." Additionally, the study found that virtual appointments for psychiatry/psychology, which is the telehealth service that Enloe Medical center in Chico offers, has the highest rate (40%) of telehealth visits out of all health services.[8]

Future Level of Deployment: This exogenous factor is expected to produce an 8%-point increase in telemedicine in the region by 2035. During a 2022 webinar panel of healthcare experts hosted by the American Medical Association (AMA), Eyal Zimlichman, MD, former advisor to the U.S. Department of Health and Human Services Office of the National Coordinator for Health Information Technology, forecasted a slow rise in telehealth visits over the next five years from the current rate of between 20% and 25% back to as high as the 70%. Dr. Zimlichman explained that, unlike the rapid, un-sustained increase brought on during the pandemic, the upcoming increase will be the result of improvements to usability and ongoing cultural shifts. Dr. Zimlichman's 50-70% estimated pandemic period usage rate is the highest estimate of telehealth use during the peak

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[7] Pillai, Akash, Bradley Corallo, and Jennifer Tolbert. Recent Trends in Community Health Center Patients, Services, and Financing. KFF, April 19, 2024. https://www.kff.org/medicaid/issue-brief/recent-trends-in-community-health-center-patients-services-and-financing/.
[8] Bestsennyy, Oleg, Greg Gilbert, Alex Harris, and Jennifer Rost. Telehealth: A Post-COVID-19 Reality?" McKinsey and Company, July 9, 2021. https://www.mckinsey.com/industries/healthcare/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality.

COVID-19 pandemic period among any of the studies researched; other studies estimate a telehealth usage rate of between 20% and 30% at the height of the pandemic.[9] BCAG therefore makes a more conservative assumption that telehealth usage rates will rise again and stabilize, but using an assumed rate of 25%, which is the usage rate during the COVID-19 peak according to the KFF study.

<u>Responsible Parties:</u> BCAG will track metrics prior to each update of the RTP utilizing available information. Possible source information includes the California Health Interview Survey (CHIS) and the California Household Travel Survey (CHTS), the Assistant Secretary for Planning and Evaluation (ASPE) Office of Health Policy's national survey trends in telehealth utilization, and Enloe Hospital's Annual Quality Summit Report.

<u>Affected Population:</u> The target population for telemedicine includes all Butte County residents seeking healthcare within the region, with a particular focus on people living in rural and underserved communities, as well as elderly individuals who have difficulty traveling on their own. Additionally, telemedicine is especially beneficial for working professionals who may prefer to consult with healthcare providers without taking time off from work.

<u>Trip and Emissions Data:</u>

- # of internal to internal (II) home-based other (HBO) trips for year 2035 = 205,718
- % subset of telemedicine activities to total personal maintenance activities = 1.25%
- % telemedicine activity increase comparing to base year = 8%
- Total II HBO VMT = 890,671
- Average II HBO trip length = 4.33 miles

Quantification Methodology:

Following the pandemic and the rise in the broader use of telemedicine services, evidence [10,11,12] has shown changes in people's travel behavior related to healthcare and how telemedicine contributes to VMT reduction. While various studies have demonstrated the magnitude of VMT and GHG emissions reductions due to the implementation and greater adoption of telemedicine, quantifying these effects specifically for the BCAG region remains challenging. To address this, the

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[9] Lee, Euny C., Violanda Grigorescu, Idia Enogieru, Scott R. Smith, Lok Wong Samson, Ann B. Conmy, and Nancy De Lew. Updated National Survey Trends in Telehealth Utilization and Modality (2021-2022). Issue Brief. Assistant Secretary for Planning and Evaluation (ASPE) Office of Health Policy, April 19, 2023.
See also: Pillai et al., 2004

[10] Dullet, N. W., Geraghty, E. M., Kaufman, T., Kissee, J. L., King, J., Dharmar, M., ... & Marcin, J. P. (2017). Impact of a university-based outpatient telemedicine program on time savings, travel costs, and environmental pollutants. Value in Health, 20(4), 542-546.

[11] Rodler, S., Ramacciotti, L. S., Maas, M., Mokhtar, D., Hershenhouse, J., Abreu, A. L. D. C., ... & Cacciamani, G. E. (2023). The impact of telemedicine in reducing the carbon footprint in health care: a systematic review and cumulative analysis of 68 million clinical consultations. European Urology Focus.

[12] Finkelstein, J. B., Hauptman, M., Acosta, K., Flanagan, S., Cahill, D., Smith, B., ... & Estrada Jr, C. R. (2024). Environmental impact of a pediatric and young adult virtual medicine program: a lesson from the COVID-19 pandemic. Academic Pediatrics, 24(3), 408-416.

methodology used by SCAG to measure the impact of telemedicine strategies will be applied, following the steps outlined below.

Step 1: Use the BCAG travel demand model for the 2022 scenario to estimate the total internal-internal (II) home-based other (HBO) vehicle trips. In the model structure, HBO trips exclude home-based shopping and home-based school trips. The remaining HBO trips are considered consistent with the maintenance activities identified in the SCAG method.

Step 2: SCAG developed the 2019 baseline model input for the telemedicine module based on the 2015-2018 California Health Interview Survey (CHIS). The percentage of telemedicine activities relative to total personal maintenance activities ranges from 0.67% to 1.59% depending on age group. A median value of 1.25% is used for the overall BCAG region.

Step 3: As discussed above, the increase in telemedicine activities compared to the base year is set at 8% points for the BCAG region.

Step 4: Use BCAG travel demand model for the 2022 scenario to estimate the average II HBO trip length.

Step 5: Calculate Telemedicine Trips using the formula:

Telemedicine Trips = II HBO vehicle trips × percentage of telemedicine activities to the total II HBO vehicle trips × percentage increase in telemedicine activities compared to base year

Step 6: Calculate the Displaced VMT using the formula:

Displaced VMT = Telemedicine Trips × average II HBO trip length

Step 7 and Step 8: Calculate the total CO2 emissions reduction using 2021 EMFAC emissions inventory.

Off-Model Telemedicine Methodology

Step #	Variable	Data Source	2035
Step 1	II HBO Vehicle Trips	BCAG model	205,718
Step 2	% subset of telemedicine activities to total personal maintenance activities	SCAG[1]	1.25%
Step 3	% telemedicine activity increase compared to base year	Placeworks	8%
Step 4	Average II HBO trip length	BCAG model	4.33
Step 5	Telemedicine Trips	Step 1 x Step 2 x Step 3	206
Step 6	Displaced VMT	CARB calculation	890.671
Step 7	Displaced private auto CO_2 emissons rate	EMFAC 2021[2]	0.000281764
Step 8	Displaced CO_2 emissions (tons)	Step 6 x Step 7	0.250959024

Source:
[1] SCAG 2019 Travel Demand Model.
[2] EMFAC2021 (v1.0.2) Emissions Inventory, BCAG Region, Year 2035, Season Annual, Total VMT = 6047689.201, Total CO2 = 1704.023793 (tons). Total CO2/Total VMT = 0.000281764 (tons).

Challenges, Constraints, and Strategy Implementation Tracking: The telemedicine rate will depend on how health care providers manage future health care services, which is uncertain. It is also possible that a rebound effect could occur if people freed up from driving to a medical appointment choose to engage in other activities that involve vehicle travel. As research on telemedicine progresses, adjustments to the methodology may need to be revised. BCAG staff will track ACS, CHIS, and CHTS data to determine the percentage change in telemedicine in the region.

ATTACHMENT E

BCAG Modification of ARB EMFAC Methodology to Calculate CO_2 Adjustment to EMFAC Output for SB 375 Target Demonstrations

See Next Page

BCAG Modification of ARB EMFAC Methodology to Calculate CO2 Adjustment to EMFAC Output for SB 375 Target Demonstrations

In 2015, ARB developed a methodology to assist metropolitan planning organizations (MPOs), such as BCAG, in adjusting the calculation of percent reduction in per capita CO2 emissions used to meet established targets when using EMFAC2011 or EMFAC2014 for their second round RTP/SCS. ARB's methodology is intended to allow for the direct comparison of reductions achieved in the first rounds of RTP/SCSs to those attained in the second and third rounds while holding each MPO to the same level of stringency in achieving the target.

A key assumption of the ARB methodology is that the 2005 baseline travel estimates developed with the first round RTP/SCS travel demand model will be identical to those produced with the updated models used to estimate travel with the second/third round RTP/SCS. However, in the case of BCAG's second round updated travel model, changes to land use data and the trip generation sub-model caused the model to generate greater estimates of per capita travel for the base year and the 2005 back-cast years in comparison to the first round RTP/SCS model. The changes in base year per capita VMT then effect the forecast years since future land uses are added to the base to develop the forecasts.

To address this change in the first and second round 2005 baseline outputs, BCAG modified the ARB methodology to incorporate an adjustment which compensates for this change in preparing the 2018 RTP/SCS. This modification is in line with the intent of the ARB methodology which seeks to neutralize the changes between the various versions of EMFAC while allowing for an "apples to apples" comparison of the first, second, and third round of RTP/SCSs. The modification was approved, along with the 2018 RTP/SCS, by ARB in 2019 as part of the SCS review.

Upon consultation with ARB in preparing the 2020 RTP/SCS, BCAG has not developed a specific "backcast" (2005), and instead will be utilizing the information from the past RTP/SCS. As such, and in accordance with the ARB's Final Sustainable Communities Strategy Program and Evaluation Guidelines (November 2019), BCAG has applied the same methodology and adjustment factors (Year 2020 = 3.81% and Year 2035 = 4.81%). It should be noted that due to the shift in removing group quarters from the population used in calculating the Per Capita CO2 (SB 375 metric) reductions, BCAG, in consultation with ARB, has normalized the population, VMT, and GHG data for the 2012 and 2020 RTPs prior to applying the adjustment.

The following table demonstrates the application of the BCAG Modified Adjustment Factor for EMFAC 2007 to EMFAC 2014, as approved for ARB for the 2012 RTP/SCS, with normalized data from the 2020 RTP/SCS.

Table 1. BCAG Modified Adjustment Factor for EMFAC 2007 to EMFAC 2014		
Determine Year 2005 Adjustment Factor	Enter 2012 SCS Total VMT for Year 2005 ->	4,090,094
	Enter 2016/2020 SCS Total VMT for Year 2005 ->	4,573,188
	Adjustment Factor (2020 SCS VMT / 2012 SCS VMT)	1.118113178
2012 SCS (EMFAC 2007)	Year 2005 CO2 Per Capita (lbs.day) ->	16.50
	Year 2020 CO2 Per Capita (lbs.day) ->	16.17
	Year 2035 CO2 Per Capita (lbs.day) ->	16.18
Apply Adjustment Factor to 2012 SCS (EMFAC 2007)	Adjusted Year 2005 CO2 Per Capita (lbs.day) ->	18.45
	Adjusted Year 2020 CO2 Per Capita (lbs.day) ->	18.08
	Adjusted Year 2035 CO2 Per Capita (lbs.day) ->	18.09
Calculate Reductions in CO2 Per Capita	Year 2020 CO2 Per Capita Percent Reductions ->	-1.98%
	Year 2035 CO2 Per Capita Percent Reductions ->	-1.91%
2012 SCS (EMFAC 2014)	Year 2020 CO2 Per Capita (lbs.day) ->	15.54
	Year 2035 CO2 Per Capita (lbs.day) ->	15.39
Apply Adjustment Factor to 2012 SCS (EMFAC 2014)	Adjusted Year 2020 CO2 Per Capita (lbs.day) ->	17.38
	Adjusted Year 2035 CO2 Per Capita (lbs.day) ->	17.21
Calculate Reductions in CO2 Per Capita	Year 2020 CO2 Per Capita Percent Reductions ->	-5.80%
	Year 2035 CO2 Per Capita Percent Reductions ->	-6.72%
Determine EMFAC 2014 Adjustment %	Year 2020 EMFAC 2014 Adjustment ->	3.81%
	Year 2035 EMFAC 2014 Adjustment ->	4.81%
2020 SCS (EMFAC 2014)	Year 2020 CO2 Per Capita (lbs.day) ->	15.21
	Year 2035 CO2 Per Capita (lbs.day) ->	16.08
Calculate Reductions in CO2 Per Capita	Year 2020 CO2 Per Capita Percent Reductions ->	-17.53%
	Year 2035 CO2 Per Capita Percent Reductions ->	-12.82%
Apply EMFAC Adjustment	Adjusted Year 2020 EMFAC 2014 ->	-13.72%
	Adjusted Year 2035 EMFAC 2014 ->	-8.01%

ATTACHMENT F

Regional Land Use Allocation Model Documentation

See Next Page

Butte County Association of Governments

Regional Land Use Allocation Model

Technical Methodology for Preparing 2024 Regional Transportation Plan / Sustainable Communities Strategy Land Use Allocations

BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

July 2024

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Contents

APPENDICES

INTRODUCTION

In 2012, BCAG, in coordination with local agency members, California State University-Chico, and the University of California at Davis, developed the Butte County region's first land use allocation model for the purpose of preparing the forecasted development pattern included in BCAG's 2012 Regional Transportation Plan (RTP) and Sustainable Communities Strategy (SCS). The model was used by BCAG in developing land use scenarios to be analyzed as part of the 2012 RTP/SCS development process and in preparing the final preferred land use scenario and allocation.

The 2016 RTP/SCS update of the land use allocation model included the addition of five (5) new job categories, new K-12 school enrollment forecasts, an occupancy adjustment of residential and non-residential land uses, and a process of normalizing the data to state sources. In 2020, the model was updated to include an adjustment to account for the loss and rebuilding of housing units and non-residential structures associated with the Camp Fire and a new base year of 2018.

In preparing the 2024 RTP/SCS, the land use allocation model has been migrated to the CommunityViz platform. The base year has been updated to 2022 and includes the latest regional growth forecasts, local general plan information, and planned projects. In addition, the local jurisdiction's latest housing elements sites inventory has been incorporated.

The following sections of the document provide an overview of the modeling process as well as details regarding specific inputs and assumptions associated with the land use allocations.

BASE YEAR DEVELOPMENT (2022)

The base year (2022) land use file was prepared using the latest available existing regional land use and school datasets. The regional existing land use dataset is updated annually as part BCAG's data maintenance program and contains the most up-to-date information regarding existing residential and non-residential land uses. School data is updated every four years and includes the latest enrollments for K-12, Chico State University, and Butte Community College.

Prior to finalizing the base year land uses, the dataset was normalized to the California Department of Finance (DOF) housing estimates and California Employment Development Department (EDD) labor force data.

Table 1 provides a summary of the base year assumptions for population, housing, and jobs.

Table 1 - Base Year (2022) Assumptions	
Population[1]	201,608
Household Population[1]	197,020
Housing Units[1]	91,549
Households[1]	91,107
Jobs[2] (Non-Farm)	77,000
Jobs/Housing Unit	0.84

BACK-CAST YEAR (2005)

In consultation with the California Air Resources Board (ARB), BCAG has decided to utilize the 2005 back-cast year from the 2016 RTP/SCS. This is the same back-cast utilized in the most recent round of Senate Bill 375 (SB 375) target setting. Therefore, there was no need to prepare a new land use dataset, as there will be no travel model runs of the dataset. For reference, Table 2 provides a summary of the 2005 back-cast year assumptions for population, housing, and jobs.

Table 2 - Back-Cast Year (2005) Assumptions	
Population[3]	214,582
Household Population[3]	208,322
Housing Units[3]	91,666
Households[3]	85,478
Jobs (Non-Farm)[2]	73,400
Jobs/Housing Unit	0.80

DEVELOPMENT OF FORECASTS

Land use allocations have been prepared according to scenarios developed by BCAG. Each allocation takes into consideration future jobs and housing based on BCAG's Long-Term Regional Growth Forecasts 2022-2045, apart from Scenario #1 which relies on the 2020 RTP/SCS preferred scenario. Appendix A contains a summary of each scenario and allocation of jobs and housing by Growth Area (Appendix B).

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[1] State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State — January 1, 2021-2022. Sacramento, California, May 2022.
[2] California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA).
[3] State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010.

The process for allocating land uses has been largely unchanged from that used in preparing the 2020 RTP/SCS. Two new datasets, housing element sites and accessory dwelling units, have been incorporated into the allocation process.

Basic Allocation Steps

1. Land Use Mask - areas identified to receive no future growth are identified and “masked”.
2. Available Capacity - data is prepared using the latest general plans, planned projects inventory, housing element sites inventory, accessory dwelling unit history, and destroyed structures inventory.
3. Allocations - jobs and housing are allocated for each individual scenario using the available capacity.

LAND USE MASK

A land use “mask” is identified for areas which are currently developed or where new growth is not permitted or reasonably foreseeable not to occur. Areas such as public parks and protected lands are examples of areas where future growth is not permitted.

In preparing the model for the 2024 RTP/SCS, staff reviewed and updated the latest available datasets to be applied to the mask. This ensured that locations newly designated for non-development or which have been developed within the past four years were accounted for.

Table 3 lists the data layers used in preparing the land use mask.

Table 3 - Mask Layers	
Public Park Lands	Areas of Slope > 25%
Existing Protected Lands	Public Lands
Existing Developed Lands	Federal Lands
Lakes	Utility Lands
Rivers	State Lands
Existing Right of Ways	Union Pacific Lands

Appendix C is included and illustrates the areas which make up the “mask” layer within the region.

AVAILABLE CAPACITY

Preparation of the available capacity follows the same overall process that was used with the 2020 RTP/SCS. The latest general plans are updated and are cross walked into the model classifications. Planned projects inventory is updated and reviewed by jurisdiction staff. Housing element inventories are updated based on the latest approved housing elements. An accessory dwelling unit (ADU) inventory is developed based on recent activity. The destroyed structures inventory is updated based on recent wildfire activity.

General Plans

A standard list of general plan classification code values were developed for use in the model as part of the 2012 RTP/SCS. Each of the jurisdiction's general plan land use classes were cross walked into one of twenty standard modeling classifications (Appendix D). This process addresses any variations in general plans across the county and allows for the implementation of a single regional general plan classification system. The purpose of the general plan modeling classifications is to restrict the type and location of new growth to designated areas when preparing the forecasted allocations. For the 2024 RTP/SCS the same twenty standard land use classifications were utilized, and the latest local general plans were applied.

Planned Projects

The inventory of planned projects are reviewed and updated by local jurisdictions with each update of the RTP/SCS. This includes the assumed number of housing units (single-family and multi-family), square footage of non-residential uses, and approximate year of construction. The planned projects layer also includes the specific/master plan areas. Appendix E illustrates the location of the planned project sites.

Housing Elements

The housing elements layer was developed by importing the local jurisdictions latest available housing elements sites inventory. For modeling, low-income unit sites are utilized as multi-family units and moderate to above income units are designated as single-family units. Appendix F illustrates the location of the housing element inventory sites.

Accessory Dwelling Units

Data from the California Department of Housing and Urban Development was reviewed for the 2019-2022 period. Based on the available data, primarily in the City of Chico, areas were designated as locations for future ADU allocation. Currently, there is very little information available on the siting of existing ADU units as well as the future capacity. For planning purposes, a minimal number (less than 350) of ADUs were designated for allocation capacity in the City of Chico based on current building activity. The current travel demand model does not have a housing designation for ADUs therefore, these units have been designated as multi-family based on travel characteristics. Appendix G illustrates the location of the traffic analysis zones identified to accept ADUs.

Destroyed Structures

Following the 2018 Camp Fire, BCAG developed a destroyed structures dataset to monitor housing units and non-residential structures lost to wildfire. This dataset was updated with information from the 2020 North Complex Fire for use in the 2024 RTP/SCS. Future capacity is based on an equal number of units or square footage destroyed, unless otherwise updated with new information from the applicable general plan.

ALLOCATING FUTURE LAND USES

Following the preparation of the mask and available capacity datasets, units are allocated to each jurisdiction based on scenario information provided in Appendix A. Population, housing, and jobs were applied to each jurisdiction using a spreadsheet tool which allocates growth within specific defined growth areas. The tool allocates future development utilizing the available capacity in the general plan, planned projects, housing element inventory, accessory dwelling units, and destroyed structures datasets. Each of these datasets is parsed by planning area and growth area to control for units and population included in the regional growth forecasts and by scenario.

Planning Areas

As with the 2020 RTP/SCS model, growth has been modeled individually at the jurisdiction level for each of the forecast years. This approach allows for each jurisdiction to retain individual land use assumptions. BCAG member jurisdictions include Biggs, Chico, Gridley, Oroville, Paradise, and the remaining unincorporated area of Butte County.

The unincorporated area of Butte County is further broken into areas adjacent to the three largest jurisdictions (Chico, Oroville, and Paradise), including the unincorporated area of Magalia.

Planning areas were adapted from a combination of jurisdiction city limits, Local Agency Formation Commission (LAFCo) spheres of influence, general plan and special planning area considerations. Planning areas do not overlap with one another and together they encompass the entirety of Butte County (Appendix H).

Growth Areas

As with past RTP/SCS's, each planning area was further broken down into Growth Areas. Planning areas were split into five Growth Areas; Center, Established, New, Rural, and Agricultural. Center growth areas are downtown and central business areas where higher densities of commercial LU's are present or planned. Established growth areas are within the current built environment and represent areas where infill and redevelopment opportunities are present. New growth areas are where new development is planned to occur outside of the currently established built environment. Rural and agricultural growth areas are only present in the unincorporated county and represent areas for growth that are separated from any incorporated area in the county. Appendix B illustrates the locations of Growth Areas.

Allocation Process

Allocations are prepared by planning area based on the regional growth forecasts and scenario descriptions. Housing units are allocated by type (single-family and multi-family) and jobs allocated by use (retail, office, industrial, etc.) based on the amount of available capacity and existing uses. A hierarchy of the datasets is established for allocation purposes as follows: 1) housing elements sites inventory 2) planned projects 3) general plan 4) accessory dwelling units 5) destroyed structures. In some cases, based on available capacity, the hierarchy must be adjusted to meet the regional control total.

The results of each scenario's forecast allocation is then combined at the region level by TAZ for incorporation in the regional travel demand model. Table 4 provides a summary of the assumptions for population, housing, and jobs accommodated by the final allocations, as well as distribution by land use category for each scenario.

Table 4 – Land Use Allocation Summary					
	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)	S4 (2045)
Population	258,113[1]	241,939[2]	241,939[2]	241,939[2]	249,169[2]
Household Population	251,863[3]	236,433[4]	236,433[4]	236,433[4]	243,499[4]
Housing Units	113,339[1]	110,000[2]	110,000[2]	110,000[2]	113,277[2]
Households	103,545[5]	101,118[6]	101,118[6]	101,118[6]	104,131[6]
Jobs (Non-Farm)	89,071[1]	92,400[2]	92,400[2]	92,400[2]	92,887[2]
Jobs/Housing Unit	0.80[1]	0.84[2]	0.84[2]	0.84[2]	0.82[2]
Residential (Households)					
Single Family	64,200	60,262	59,293	58,911	60,523
Multi-Family	27,925	30,724	32,055	32,441	33,823
Mobile/Manufactured Home	11,420	10,140	9,812	9,812	9,844
Non-Residential (Jobs)					
Retail	27,892	28,774	26,458	25,458	25,458
Industrial	15,146	17,364	17,477	17,447	17,477
Office	23,840	24,311	26,336	26,554	26,699
Medical Office	7,462	7,603	7,712	7,871	7,872
Public	3,997	4,312	4,312	4,421	4,521
Hospitals	3,419	3,070	3,070	3,070	3,086
Hotels	980	1,120	1,120	1,120	1,126
University	2,102	1,737	1,737	2,010	2,122
Butte College	1,331	1,327	1,327	1,579	1,587
K-12 Schools	2,864	2,736	2,736	2,736	2,750
Casino	124	108	108	108	109

Sources:
[1] BCAG Long-Term Regional Growth Forecasts 2018-2040 (medium scenario)
[2] BCAG Long-Term Regional Growth Forecasts 2022-2045 (medium scenario)
[3] Household population based on the 2018 ratio of group quarters population to overall population
[4] Household population based on the 2022 ratio of group quarters population to overall population
[5] Persons Per Household – State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State — January 1, 2010-2019. Sacramento, California, May 2019
[6] Persons Per Household - State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State — January 1, 2021-2022. Sacramento, California, May 2022

MODEL UPDATES AND IMPROVEMENTS

Below are the general updates and improvements made to the BCAG land use allocation model for the 2024 RTP/SCS.

UPDATES

Existing Land Use

The 2024 RTP/SCS includes an updated base year representative of January 1, 2022. As such, the existing land use for year 2022 was updated with BCAG's annually updated Geographic Information System (GIS) database which is compiled from local jurisdiction building report data. In addition, school enrollment is updated at the K-12, Community College, and University levels based on district and state reported data.

General Plan

BCAG maintains an annually updated local general plan GIS dataset. Annually, local jurisdictions are asked to report general plan land use updates. Typically, these are minor changes effecting one or two parcels. BCAG then adjusts the regional general plan dataset.

Planned Projects

Prior to preparing forecasts, BCAG reviews and requests updates to the planned projects dataset from each local jurisdiction. This often includes the addition or removal of planned projects based on planning department input.

Land Use Masks

Prior to preparing the capacity datasets, BCAG reviews the mask layer (areas not available for future development) and updates as necessary. This includes the updating of existing development, public and protected lands, undevelopable lands, etc.

IMPROVEMENTS

Accessory dwelling units and housing element sites inventories were incorporated into the 2024 RTP/SCS land use allocation model.

Accessory Dwelling Units

BCAG was able to obtain accessory dwelling unit (ADU) information from the California Department of Housing and Community Development for the period 2018-2022. This information showed accessor parcel numbers and certificate of occupancy dates for ADU's in the region. The City of Chico showed the completed construction of 152

ADU's over that 4-year period. With this information, BCAG developed an inventory of existing ADU's designated by associated traffic analysis zones (TAZ) to allow for future allocation of units to TAZ's.

Housing Element Sites Inventory

Housing element sites inventories were collected from the latest available housing elements published by the local jurisdictions. This information contained associated assessor parcel numbers which were mapped by BCAG. Low-income units were designated as future available capacity for multi-family units. Moderate and above moderate – income units were designated as future available capacity for single-family units.

APPENDIX A

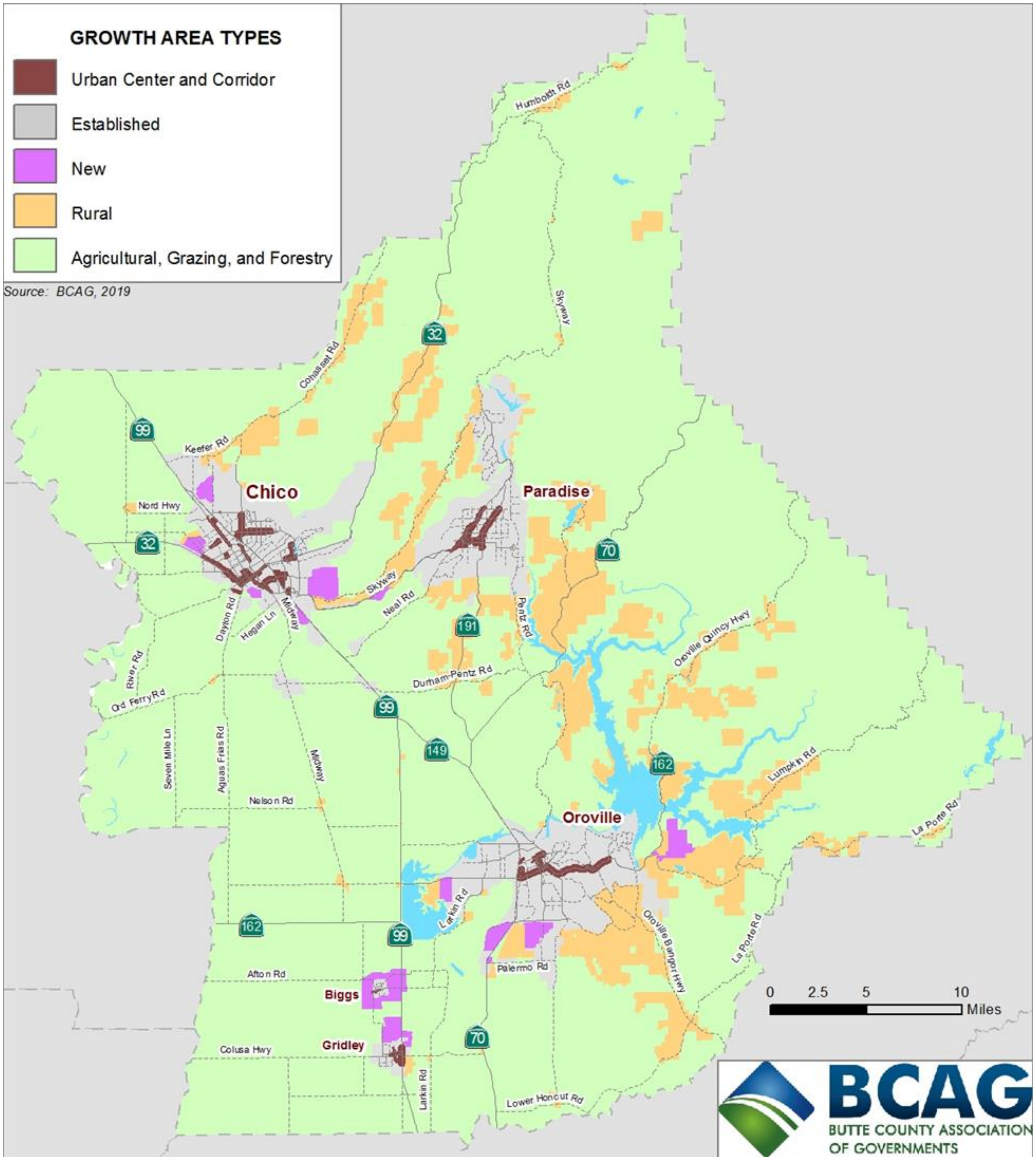
Summary of Land Use Allocation by Scenario

New Housing Units					
Growth Area	**Scenario #1 (2035)**	**Scenario #2 (2035)**	**Scenario #3 (2035)**	**Scenario #4 (2035)**	**Scenario #4 (2045)**
Center	6%	6%	20%	20%	20%
Established	56%	56%	60%	66%	66%
New	30%	30%	17%	11%	11%
Rural	6%	6%	2%	2%	2%
Ag	2%	2%	1%	1%	1%
	100%	100%	100%	100%	100%
New Housing Mix					
Housing Type	**Scenario #1 (2035)**	**Scenario #2 (2035)**	**Scenario #3 (2035)**	**Scenario #4 (2035)**	**Scenario #4 (2045)**
Single Family[1]	68%	68%	61%	58%	58%
Multi-Family	32%	32%	39%	42%	42%
	100%	100%	100%	100%	100%
New Jobs					
Growth Area	**Scenario #1 (2035)**	**Scenario #2 (2035)**	**Scenario #3 (2035)**	**Scenario #4 (2035)**	**Scenario #4 (2045)**
Center	26%	26%	31%	31%	31%
Established	60%	60%	58%	59%	59%
New	11%	11%	9%	8%	8%
Rural	3%	3%	2%	2%	2%
Ag	1%	1%	1%	1%	1%
	100%	100%	100%	100%	100%
Jobs - Housing Ratio					
Sub-Region	**Base Year (2022)[2]**	**Scenario #2 (2035)**	**Scenario #3 (2035)**	**Scenario #4 (2035)**	**Scenario #4 (2045)**
Biggs/Gridley	1.25	1.24	1.19	1.19	1.15
Chico/Chico Co	0.97	0.94	0.95	0.95	0.93
Oroville/Oroville Co	0.88	0.93	0.89	0.89	0.86
Paradise/Paradise Co/Magalia Co	0.65	0.74	0.68	0.65	0.64
Remaining Uninc	0.36	0.36	0.37	0.38	0.36
Total	0.84	0.84	0.84	0.84	0.82

[1] Single family units include mobile/manufactured homes

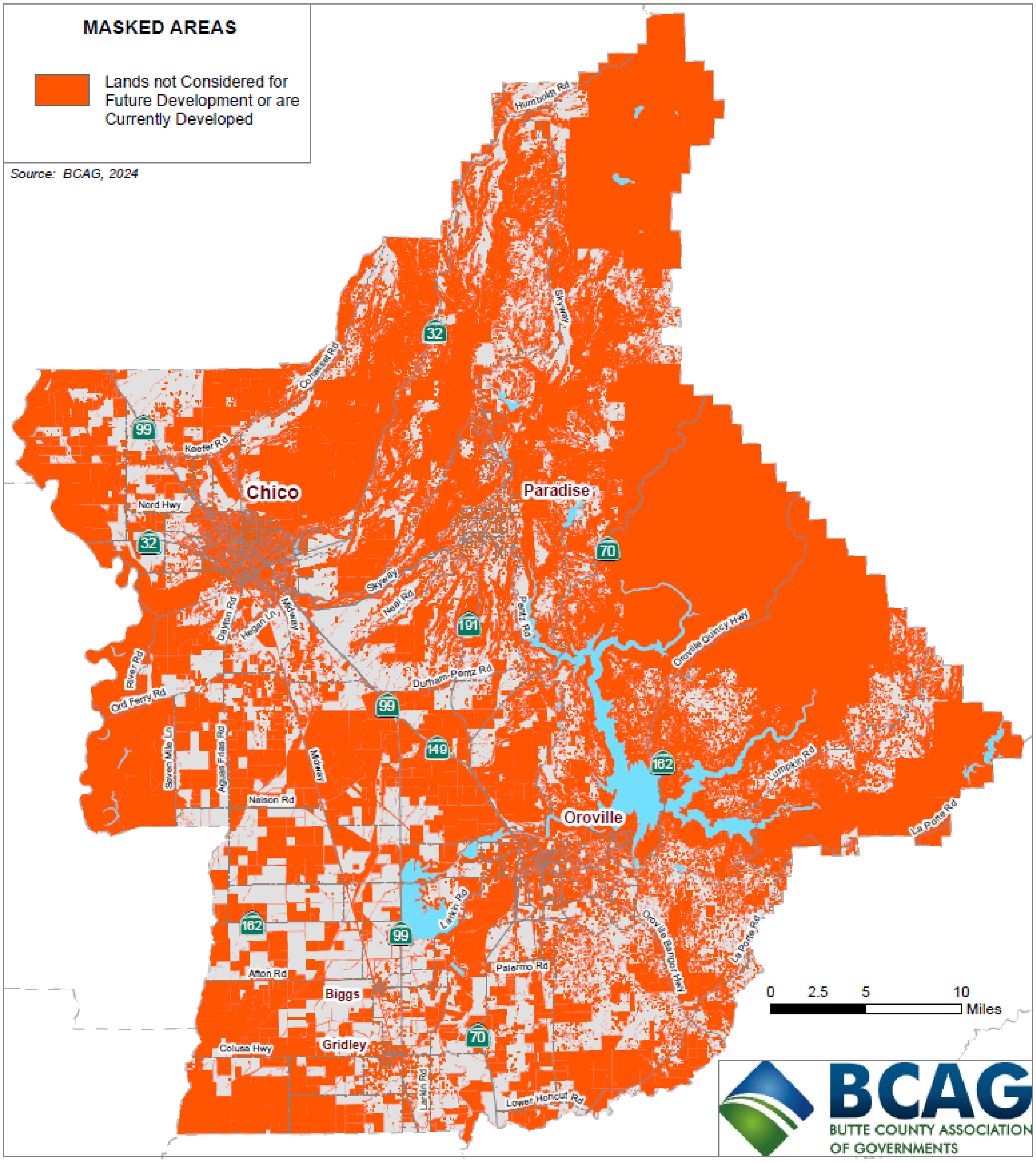
[2] Jobs-housing ratio is not available for Scenario #1 (2020 RTP/SCS) dataset. Base year 2022 information provided.

APPENDIX B



GROWTH AREA TYPES
Urban Center and Corridor
Established
New
Rural
Agricultural, Grazing, and Forestry
Source: BCAG, 2019
Chico
Paradise
Oroville
Biggs
Gridley
Humboldt Rd
Skyway
Cohasset Rd
Keefer Rd
Nord Hwy
Neal Rd
Dayton Rd
Hegan Ln
Midway
Pentz Rd
Oroville Quincy Hwy
Durham-Pentz Rd
River Rd
Ord Ferry Rd
Seven Mile Ln
Aguas Frias Rd
Nelson Rd
Lumpkin Rd
La Porte Rd
Larkin Rd
Oroville Bangor Hwy
Palermo Rd
Afton Rd
Colusa Hwy
Lower Honcut Rd
99
32
70
191
149
162
0 2.5 5 10
Miles
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

APPENDIX C

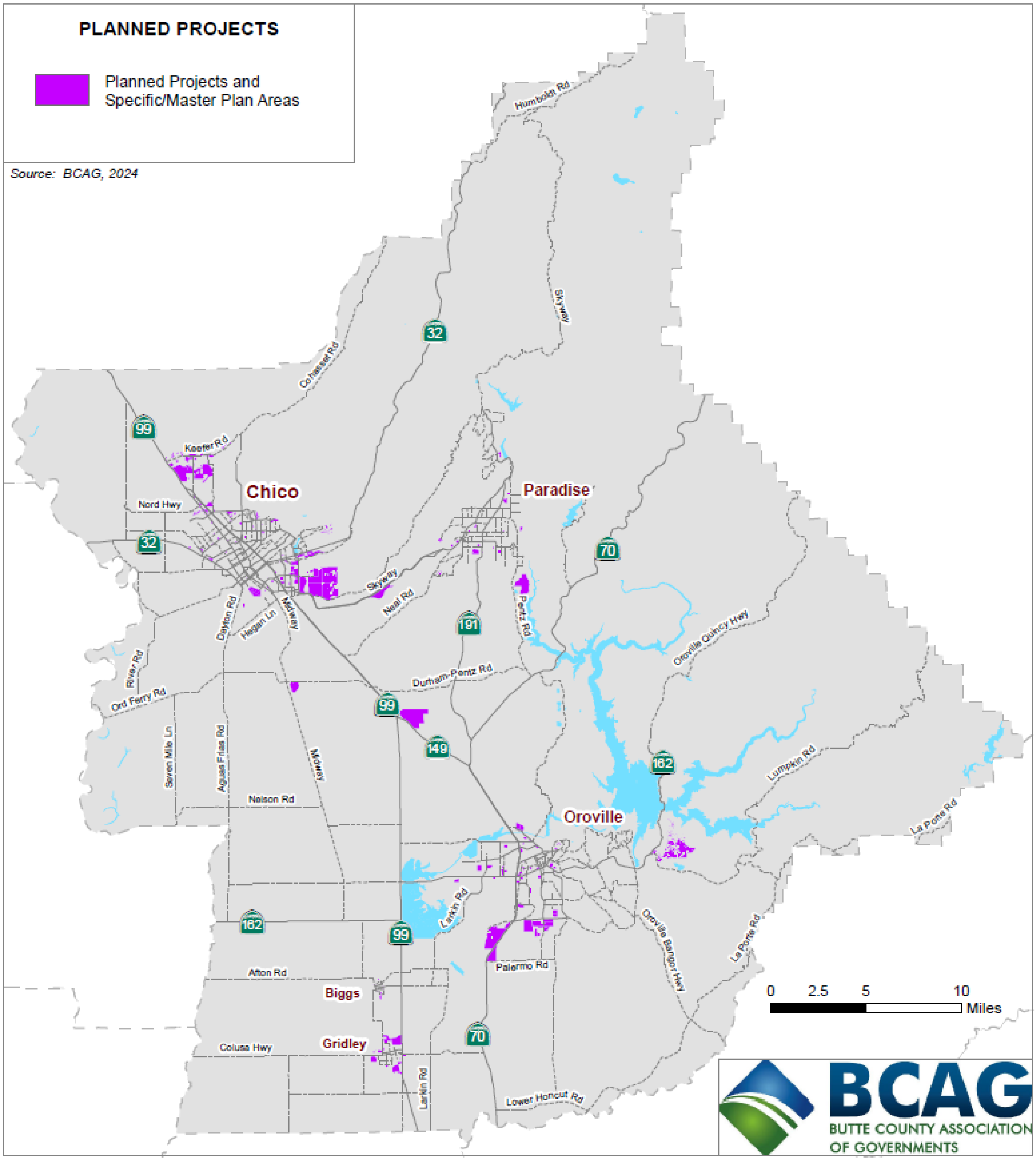

MASKED AREAS
Lands not Considered for Future Development or are Currently Developed
Source: BCAG, 2024
Chico
Paradise
Oroville
Biggs
Gridley
Humboldt Rd
Skyway
Cohasset Rd
Keefer Rd
Nord Hwy
Neal Rd
Durham-Pentz Rd
Pentz Rd
Oroville Quincy Hwy
Dayton Rd
Hegan Ln
Midway
River Rd
Ord Ferry Rd
Seven Mile Ln
Aguas Frias Rd
Nelson Rd
Lumpkin Rd
La Porte Rd
Larkin Rd
Oroville Bangor Hwy
Palermo Rd
Afton Rd
Colusa Hwy
Lower Honcut Rd
0 2.5 5 10 Miles
BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

APPENDIX D

General Plan Class to Model Class Crosswalk

Model Code	Model Classification	TransCAD Classification	City of Chico 2030 GP (Final)	Town of Paradise 1994 GP	City of Gridley GP 2030 (Final)	City of Biggs GP 2030 (Pending)	City of Oroville GP 2030 (Final)	Butte County GP 2030 (Final)
0	Unclassified	N/A			Right of Way (ROW), Right of Way Railroad (ROWR), Right of Way Water (ROWW)	Right of Way (ROW), Railroad ROW (RR)	Right of Way (ROW)	Right of Way (ROW), Sports and Entertainment (SE)
1	Agriculture	N/A			Agriculture (AG)	Agriculture (A)		Agriculture (AG)
2	Industry	IND_KSF	Manufactoring and Warehouse (MW)			Agriculture Industrial (AI), Heavy Industrial (HI)	Industrial (IND)	Industrial (I)
4	Agriculture	N/A				Agriculture Commercial (AC)		
5	Office Commercial	OFF_KSF					Office (OFC)	
6.1	Mixed Use Retail	RET_KSF & OFF_KSF	Neighborhood Commercial (NC)	Neighborhood Commercial (NC)	Downtown Mixed Use (DMU)	Commercial (C)	Mixed Use Commercial (MUC)	Mixed Use (MU)
6.2	Mixed Use Retail	RET_KSF & OFF_KSF & MF_DU	Commercial Mixed Use (CMU)	Central Commercial (CC)	Neighborhood Center Mixed Use (MU)	Downtown Mixed Use (DMU)	Retail and Business Services (RBS)	Retail and Office (RTL)
6.3	Mixed Use Retail	RET_KSF & OFF_KSF & MF_DU	Commercial Mixed Use (CMU) with Downtown or Corridor Overlays (OS-3, 7, 9, 13, 14, 15)	Town Commercial (TC)	Commercial (C)	Mixed Use (MU)	Airport Business Park (ABP)	Industrial (I) and Rural Residential (RR) with Retail Overlay (Retail)
6.4	Mixed Use Retail	RET_KSF & OFF_KSF & IND_KSF	Commercial Services (CS)	Business Park (BP)				Recreation Commercial (REC)
6.5	Mixed Use Retail	RET_KSF & OFF_KSF & MF_DU	Regional Commercial (RC)	Community Service (CS)				Research and Business (RBP)
6.6	Mixed Use Office	RET_KSF & OFF_KSF & MF_DU	Office Mixed Use (OMU)					
6.7	Mixed Use Office	RET_KSF & OFF_KSF & MF_DU	Office Mixed Use (CMU) with Downtown or Corridor Overlays (OS-3, 7, 9, 13, 14, 15)					
7	Mixed Use Industrial	IND_KSF & OFF_KSF	Industrial Office Mixed Use (IOMU)	Light Industrial (LI)	Industrial (M), Agriculture Industrial (AI)	Light Industrial (LI)		Agriculture Services (AS)
8.1	Mixed Use Residential	MF_DU & RET_KSF & OFF_KSF	Residential Mixed Use (RMU)					
8.2	Mixed Use Residential	MF_DU & RET_KSF & OFF_KSF	Residential Mixed Use (RMU) with Downtown and Corridor Overlays (OS-3, 7, 9, 13, 14, 15)					
9	High Density Residential	MF_DU	High Density Residential (HDR)		Residential High Density 2 (RHD 2)	High Density Residential (HDR)	High Density Residential (HDR)	High Density Residential (HDR)
10	Medium-High Density Residential	MF_DU	Medium-High Density Residential (MHDR)	Multi-Family Residential (MR)			Medium High Density Residential (MHDR)	
11	Medium Density Residential	SF_DU	Medium Density Residential (MDR)		Residential High Density 1 (RHD 1)	Medium Residential (MDR)	Medium Density Residential (MDR)	Medium High Density Residential (MHDR)
12	Low Density Residential	SF_DU	Low Density Residential (LDR)	Rural Residential (RR) and Town Residential (TR)	Residential Medium Density (RMD), Residential Low Denisty (RLD)	Low Density Residential (LDR)	Medium Low Density Residential (MLDR)	Medium Density Residential (MDR)
13	Very Low Density Residential	SF_DU	Very Low Density Residential (VLDR)	Agricultural Residential (AR)	Residential Very Low Density (RS)		Low Density Residential (LDR)	Very Low Density Residential (VLDR), Low Density Residential (LDR)
14	Rural Residential	SF_DU						Foothill Residential (FR), Rural Residential (RR)
15	Planned Development	N/A	Special Mixed Use (SMU)					Planned Unit Development (PUD)
16	Public Lands & Open Space	N/A	Primary Open Space (POS), Secondary Open Space (SOS)	Recreational (R), Open Space/Agricultural (OS/AG)	Park (PARK), Open Space (OS)		Park (PARK), Environmental Conservation/Safety (ECS), Resource Management (RM)	Resource Conservation (RC)
17	Water Bodies	N/A					State Water Project (SWP)	
18	Urban Reserve	N/A			Urban Reserve (UR)			
19	Timber	N/A		Timber Production (TP)				Timber Mountain (TM)
20	Public Facilities	N/A	Public Facilities and Services (PFS)	Public Institutional (PI)	School (S), Public (PUB)	Public (P)	Public (PUB)	Public (P)

APPENDIX E


PLANNED PROJECTS
Planned Projects and Specific/Master Plan Areas
Source: BCAG, 2024
Chico
Paradise
Oroville
Biggs
Gridley
Humboldt Rd
Skyway
Cohasset Rd
Keefer Rd
Nord Hwy
Neal Rd
Pentz Rd
Dayton Rd
Hegan Ln
Midway
River Rd
Ord Ferry Rd
Durham-Pentz Rd
Oroville Quincy Hwy
Seven Mile Ln
Aguas Frias Rd
Nelson Rd
Lumpkin Rd
La Porte Rd
Larkin Rd
Oroville Bangor Hwy
Palermo Rd
Afton Rd
Colusa Hwy
Lower Honcut Rd
99
32
70
191
149
162
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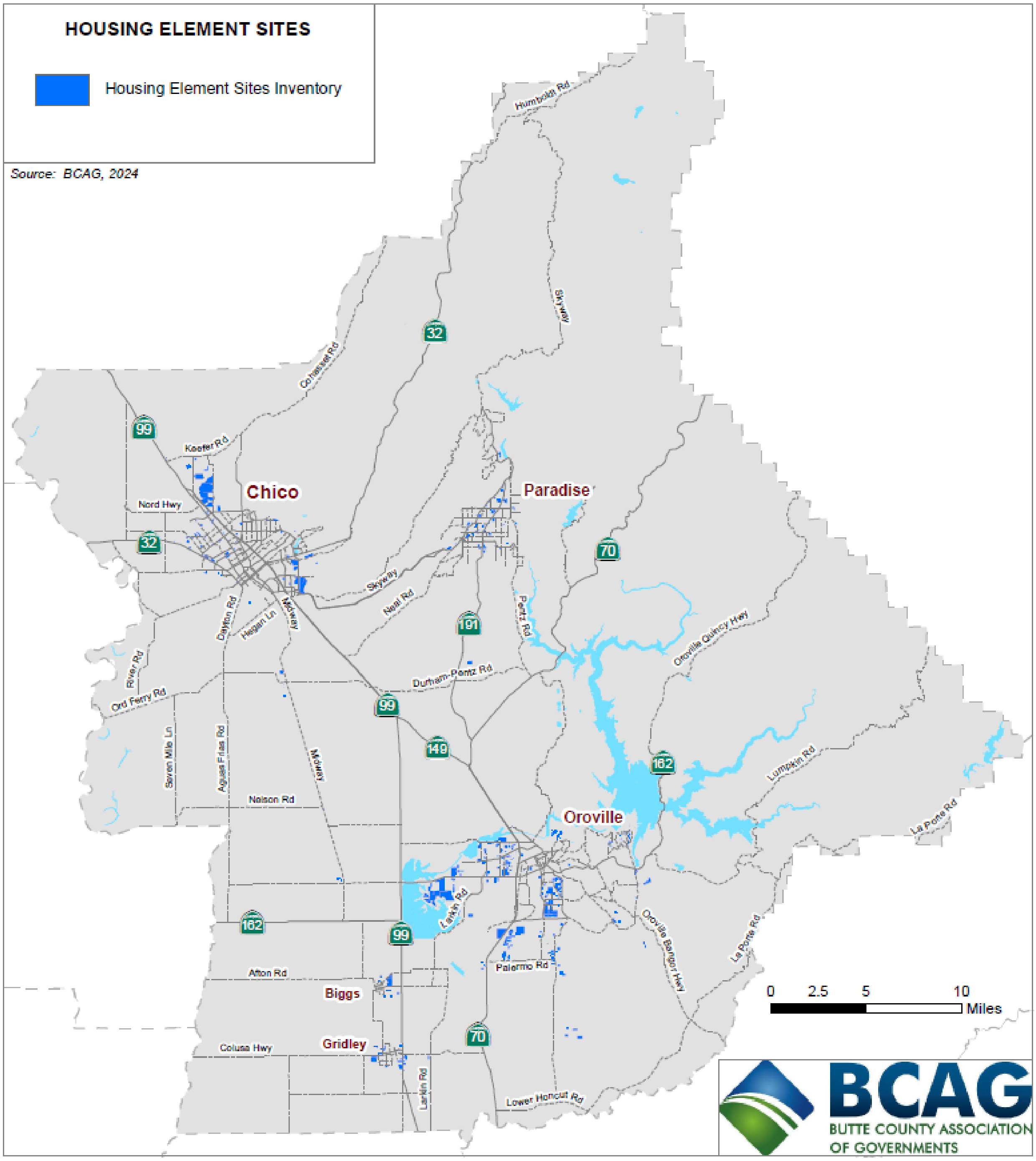
Miles
BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

APPENDIX F



HOUSING ELEMENT SITES
Housing Element Sites Inventory
Source: BCAG, 2024
Chico
Paradise
Oroville
Biggs
Gridley
Humboldt Rd
Skyway
Cohasset Rd
Keefer Rd
Nord Hwy
Neal Rd
Pentz Rd
Durham-Pentz Rd
Dayton Rd
Hegan Ln
Midway
River Rd
Ord Ferry Rd
Seven Mile Ln
Aguas Frias Rd
Nelson Rd
Oroville Quincy Hwy
Lumpkin Rd
La Porte Rd
Larkin Rd
Palermo Rd
Oroville Bangor Hwy
Afton Rd
Colusa Hwy
Lower Honcut Rd
99
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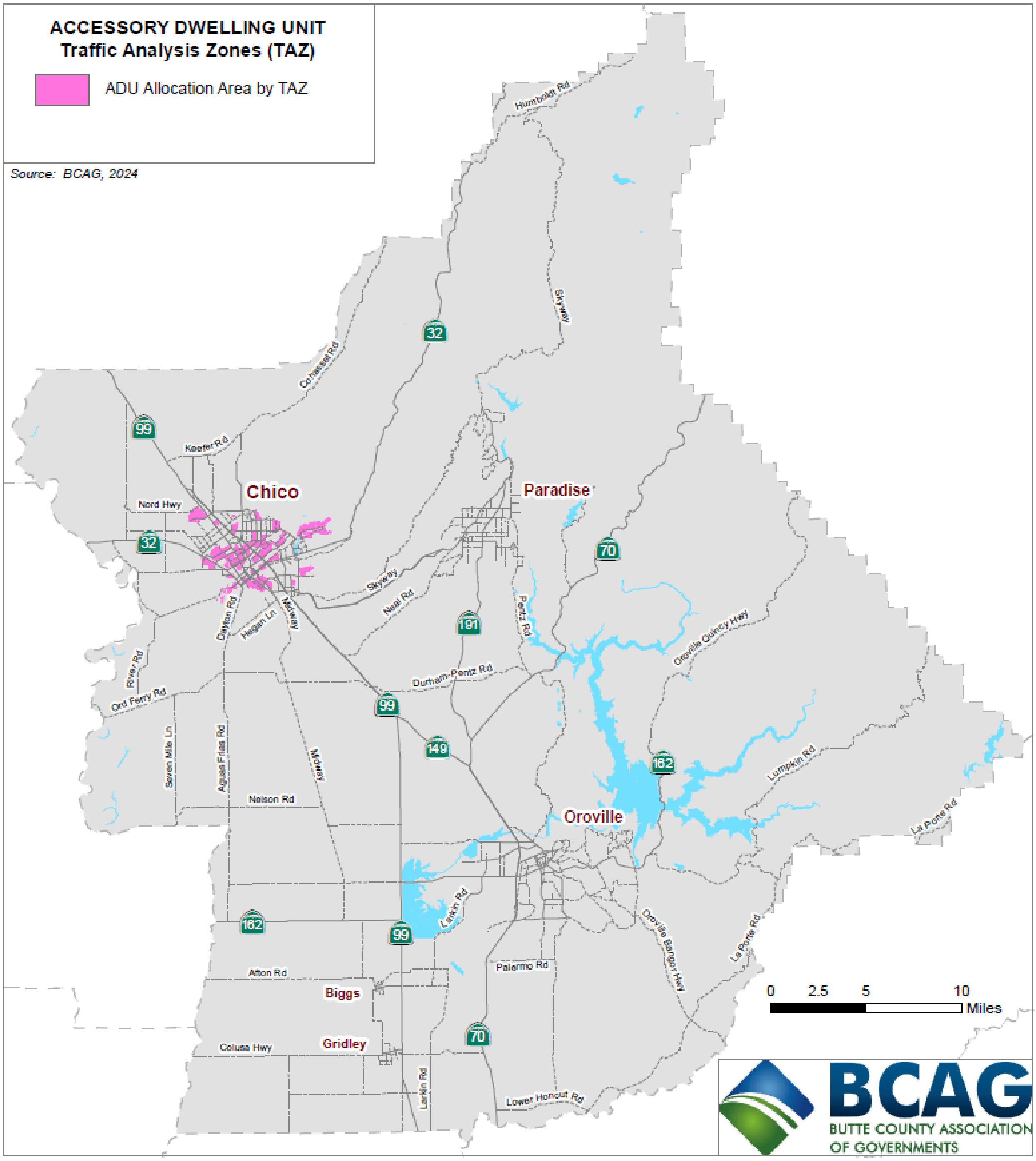
162
0 2.5 5 10 Miles
BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

APPENDIX G


ACCESSORY DWELLING UNIT
Traffic Analysis Zones (TAZ)
ADU Allocation Area by TAZ
Source: BCAG, 2024
Humboldt Rd
Skyway
32
Cohasset Rd
99
Keefer Rd
Chico
Paradise
Nord Hwy
32
70
Skyway
Neal Rd
191
Pentz Rd
Dayton Rd
Hegan Ln
Midway
Oroville Quincy Hwy
River Rd
Ord Ferry Rd
Durham-Pentz Rd
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Seven Mile Ln
Aguas Frias Rd
Midway
182
Lumpkin Rd
Nelson Rd
Oroville
La Porte Rd
Larkin Rd
162
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Oroville Bangor Hwy
La Porte Rd
Afton Rd
Palermo Rd
Biggs
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Gridley
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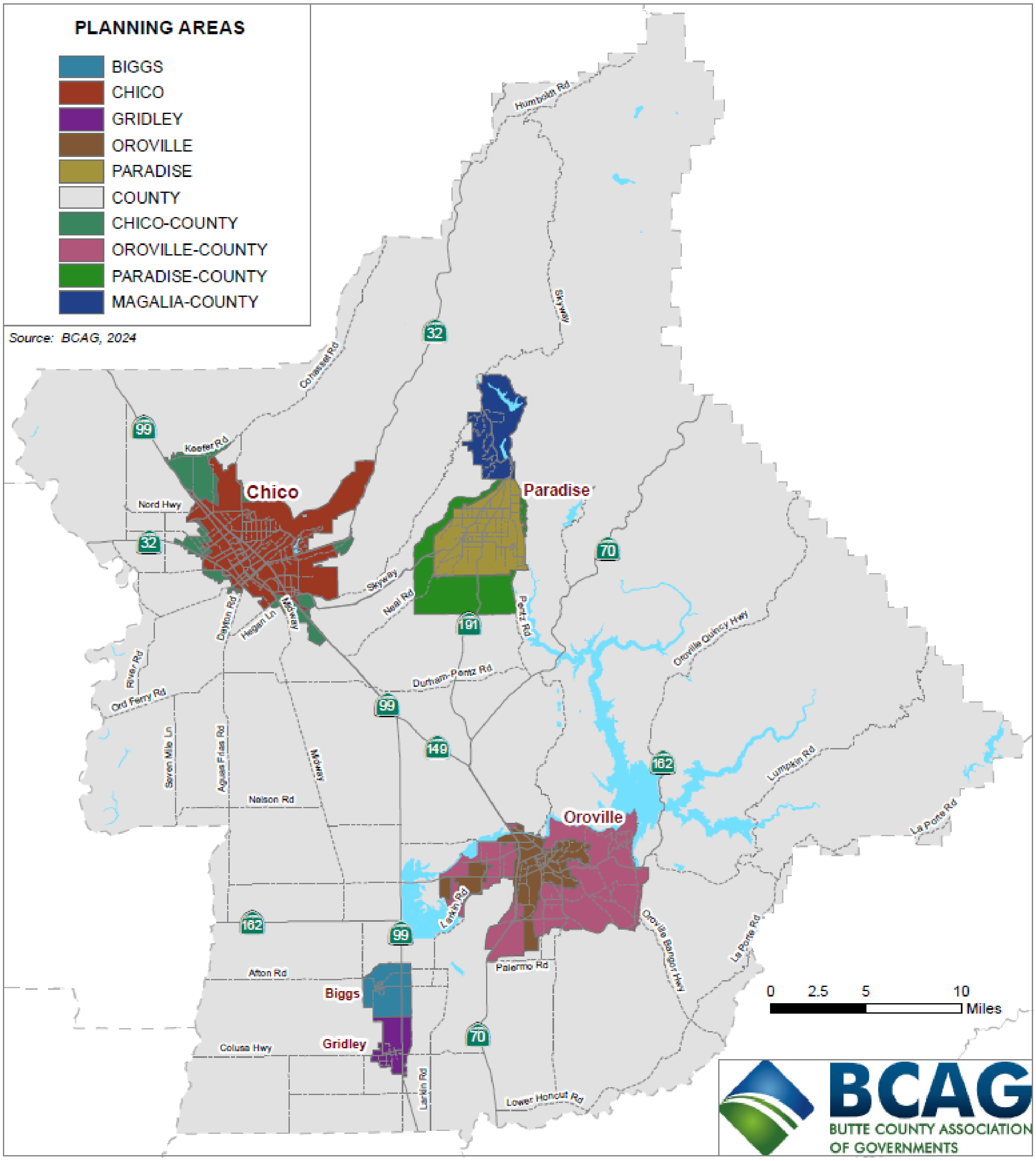
Colusa Hwy
Larkin Rd
Lower Honcut Rd
BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

APPENDIX H



PLANNING AREAS
BIGGS
CHICO
GRIDLEY
OROVILLE
PARADISE
COUNTY
CHICO-COUNTY
OROVILLE-COUNTY
PARADISE-COUNTY
MAGALIA-COUNTY
Source: BCAG, 2024
Chico
Paradise
Oroville
Biggs
Gridley
Humboldt Rd
Skyway
Cohasset Rd
Keefer Rd
Nord Hwy
Neal Rd
Pentz Rd
Dayton Rd
Hegan Ln
Midway
River Rd
Ord Ferry Rd
Durham-Pentz Rd
Oroville Quincy Hwy
Seven Mile Ln
Aguas Frias Rd
Nelson Rd
Lumpkin Rd
La Porte Rd
Larkin Rd
Oroville Bangor Hwy
Palermo Rd
Afton Rd
Colusa Hwy
Lower Honcut Rd
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BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

ATTACHMENT G

Induced Travel Demand Off-Model Adjustment

See Next Page

Induced Travel Demand Off-Model Adjustment

This document provides forecasts of long-term induced VMT associated with roadway capacity expansion projects included in the BCAG RTP/SCS. The forecast acknowledges that the BCAG travel demand model is limited to predicting short-term induced VMT effects, as it lacks a feedback mechanism to account for long-term land use growth, which may induce additional vehicle travel. As a result, long-term induced VMT could exceed the levels forecasted by the model alone.

To estimate long-term induced VMT, an alternative "elasticity" method, based on several research studies, is employed. However, it's important to note that this method is not fully sensitive to variations in the built environment and does not account for the suburban, rural, and agricultural land use context or the limited congestion found in Butte County.

Three different options are evaluated, as shown below, with Option 3 selected to demonstrate long-term induced VMT effects. The rationale for this selection is discussed in the comments section of the table below.

Alternative Long-Term Induced Weekday Passenger Vehicle VMT Forecasts for the BCAG RTP/SCS

Elasticity Method	2035 Option 1	2035 Option 2	2035 Option 3	Comments
Short-run elasticity	NA	0.024	0.024	Data Source: BCAG RTP/SCS Model Development Report (2024)
Class 2 and 3 lane miles	390	390	390	Based on CARB's research on induced travel[1], only Class 2 and 3 lane-miles are accounted to estimate induced VMT.
Class 2 and 3 VMT	2,804,315	2,804,315	2,804,315	Data Source: BCAG RTP/SCS Model Development Report (2024)
Total elasticity (Literature)	0.75	0.75	0.75	California Induced Travel Calculator (ucdavis.edu)
Elasticity portion for increased commercial driving	Not applied	0.2175	0.2175	This elasticity excludes induced commercial driving using the same ratios identified in Duranton and Turner (2011)[2] for the accounting of induced VMT effects since SB 375 excludes commercial vehicle VMT.
Elasticity portion for induced population growth	Not applied	Not applied	Not applied	Unlikely that population growth would be attracted away from other counties due to roadway capacity expansion in Butte County.
Elasticity portion for traffic diversion	Not applied	0.075	Not applied	Unlikely to occur due to drivers typically taking longer distance routes to avoid congestion.

Elasticity Method	2035 Option 1	2035 Option 2	2035 Option 3	Comments
Elasticity portion for increased household driving	Not applied	0.2925	Not applied	This value could be reduced or excluded on the basis that household driving is unlikely suppressed by congestion in Butte County. This can be verified for vehicle trip generation on the basis of the model's trip rates being similar to ITE rates, which tend to represent full demand in suburban areas where congestion is limited. However, evidence is not available to verify if trip lengths would be affected. As such, maintaining this portion of the elasticity would account for that possibility.
Long-term induced passenger vehicle VMT elasticity after added/subtracted of short-run estimate	0.75	0.14	0.51	
Lane mile increase in 2035	0.64	0.64	0.64	As explained above, only lane mile increases on Class 2 and 3 facilities are accounted.
Long-term induced passenger vehicle weekday VMT[3]	3,451	649	2,340	Option 1 shows the maximum long-term induced VMT forecast using the full literature-based elasticity value. This value does not consider the local context of Butte County as discussed in the comments. Option 2 discounts the elasticity for those elasticity components not expected to apply in Butte County. Under the three options, an alternative conclusion is that Option 3 accounted for the necessary adjustments to the full literature-based elasticity value with consideration of the local context of Butte County and is selected to demonstrate the long-term induced weekday passenger vehicle VMT forecasts for Butte County under 2035 condition.

Data Source:

[1]Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions Policy Brief

[2]The Fundamental Law of Road Congestion: Evidence from US Cities, Gilles Duranton and Matthew A. Turner, American Economic Review 101, October 2011

[3]California Induced Travel Calculator Forecast of Total Weekday VMT is 37,530 for 2019 conditions. Adjusting for commercial vehicle travel, the net weekday passenger vehicle induced VMT is 26,650.

As outlined in the table above, Option 3 was selected, showing the long-term induced weekday passenger vehicle VMT as 2,340 for Butte County. This forecasted value is used in the table below to calculate the total CO2 emission increase, based on the 2021 EMFAC emissions inventory.

Long-Term Induced Travel Adjustment Methodology

Step #	Variable	Data Source	2035
Step 1	Long-Term Induced Passenger Vehicle VMT	BCAG	2,340
Step 2	Private auto CO_2 emissons rate	EMFAC 2021[1]	0.000281764
Step 3	CO_2 emissions (tons/day)	Step 1 x Step 2	0.659355009

Source:

[1] EMFAC2021 (v1.0.2) Emissions Inventory, BCAG Region, Year 2035, Season Annual, Total VMT = 6047689.201, Total CO2 = 1704.023793 (tons). Total CO2/Total VMT = 0.000281764 (tons).

ATTACHMENT H

Regional Travel Demand Model Documentation

See Next Page

FINAL

BCAG 2024 RTP Travel Demand Model

BCAG V2.0 - Development Report

Prepared for

BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

September 2024

FEHR & PEERS

RS22-4241

Final

BCAG 2024 RTP Travel Demand Model

Model Version 2.0 Development Report

Prepared for:
Butte County Association of Governments

September 2024

RS22-4241

FEHR PEERS

Table of Contents

List of Appendices

List of Figures

List of Tables

1 Introduction

This report presents the Travel Demand Forecasting (TDF) model built for the Butte County Association of Governments (BCAG) in preparation for the 2024 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) Update. This report describes the model development process, including the data sources used to develop key model inputs.

General Discussion of the TDF Model

This section summarizes the answers to commonly asked TDF model questions and how BCAG can use the model.

What is a TDF model?

A TDF model is a computer program that simulates traffic levels and travel patterns for a specific geographic area. The program consists of input files that summarize the area's land uses, roadway network, travel characteristics, and other key factors. Using this data, the model performs a series of calculations to determine the number of trips generated, the beginning and ending location of each trip, the mode of travel for each trip, and the route taken by the trip. The model's output includes projections of traffic volumes on major roads and important metrics such as vehicle miles of travel (VMT) needed for emissions forecasts and environmental impact analysis.

How is a TDF model useful?

The TDF model is a valuable tool for preparing long-range transportation planning studies, like the RTP. The TDF model can be used to estimate the average daily traffic volumes on the major area roads in response to planned population and employment growth, changes in transportation infrastructure, and policy assumptions; it also provides a consistent platform to analyze different land use and transportation scenarios.

How do we know if the TDF model is accurate?

To be deemed accurate for projecting traffic volumes in the future, a model must first be calibrated to a year in which actual land use data and traffic volumes are available and well-documented. A model is accurately validated when it replicates actual traffic counts on the major area roads within certain ranges of error established in the *2024 California Regional Transportation Plan Guidelines* (California Regional Transportation Plan Guidelines. (2024). Sacramento, CA: California Transportation Commission.) and it demonstrates stable responses to varying levels of inputs.

The BCAG model has been calibrated and validated to 2022 base year conditions using observed traffic counts, census data travel survey estimates, big data (StreetLight Data, Inc.), and land use data compiled by BCAG staff.

Is the BCAG TDF model consistent with standard practices?

The BCAG model is consistent in form and function with standard travel forecasting models used in transportation planning. The model includes a land-use based trip generation module, a gravity-based trip distribution model, a capacity-constrained equilibrium traffic assignment process, and a mode choice component that estimates transit, walk, and bike trips and generates auto trips for drive alone, shared ride with two people, and shared ride with three or more people. In addition to passenger travel, a separate truck trips model is included. The travel model uses Version 6.5 Citilabs Cube Voyager transportation planning software, which is consistent with many of the models used by local jurisdictions in California and throughout the nation.

How can the TDF model be used?

The TDF model can be used for many purposes related to the planning and design of Butte County's transportation system. The following is a partial listing of the potential uses of the model.

- To update the RTP/SCS
- To estimate VMT for emissions analysis and SB 743 compliant transportation impact studies
- To analyze land use and circulation elements of city or county general plans
- To conduct a regional transportation mitigation fee program
- To evaluate the traffic impacts of area-wide land use plan alternatives
- To evaluate the shift in traffic resulting from a roadway improvement
- To evaluate the traffic impacts of land development proposals
- To determine trip distribution patterns of land development proposals
- To support the preparation of project development reports for Caltrans

What are the TDF model limitations?

The BCAG TDF Model has been developed for regional planning purposes within a trip-based model framework. The model conforms to the recommendations outlined in the 2024 Regional Transportation Guidelines for Group B2 metropolitan planning organization (MPO) but does have limitations.

- The current structure has limited sensitivity to factors that may affect trip generation rates such as significant declines in economic activity. (e.g., COVID-19 effects). However, since the model has a land use occupancy component, economic cycles can be reflected in the assumed intensity of land uses within the model.
- Although the model network includes all local roadways, not all local roadways are assigned vehicle trips. Use of the model for local applications will require sub-area refinements and validation to ensure the model is appropriately sensitive to changes at this scale.
- A new mode choice component was added to the v1.0 BCAG model which was originally prepared for 2020 RTP/SCS. However, due to the lack of more recent mode choice survey data, the base year 2022 condition is still calibrated based on the 2010-2012 California Household Travel Survey, which might not fully align with the current post-pandemic conditions. Future

model updates would benefit from more current household travel surveys, on-board transit survey, and additional data sources such as Big Data.

- Model parameters relying on household travel survey data are based on a small sample size. The current household travel survey data is from 2010-2012 California Household Travel Survey which might be outdated especially with the travel behavior changes associated with post pandemic conditions. Additional big data (StreetLight Data, Inc.) is used to calibrate the model parameters to better reflect the base year 2022 condition. However, future model updates would benefit from a larger sample of households in Butte County and a more recent household travel survey.
- The trip-based model structure does not allow for complete estimates of forecasts of vehicle trips (VT) or vehicle miles traveled (VMT) generated by residential households or individual persons. Vehicle trips are assigned at the TAZ level and any connection to individual land uses that originally generated the trips are lost. VT and VMT can be expressed as ratios such as VMT per capita or VMT per household. But these ratios are based only on dividing total VMT by the number of people or households in the model area. It does not indicate the level of VT or VMT being generated.
- New technologies in the automotive market, such as autonomous vehicles (AV), are not currently included in the BCAG model. As AV penetration occurs and their operation on local roadways becomes more common, general travel behavior is expected to change. However, there is currently insufficient evidence or data to accurately assess the impact of AVs on trip generation and mode split, so AV technology is not incorporated in the current version of the BCAG model. As more data and studies on AVs become available, future updates to the model should consider including AVs in the model structure.

What updates were made to this version of the model?

When preparing 2020 RTP/SCS, major updates and changes were done for the BCAG model, including the change of platform from TransCAD to Cube, major improvements in trip generation process, and additional features including travel cost function, mode choice model and other updates. For 2024 RTP/SCS, the model base year was updated from 2018 to 2022. Additional significant refinements or changes include upgrading the model run structure from Cube Catalog to Cube Voyager. Besides this change, other updates include model input updates, model re-calibration with big data, and feature improvements. All the updates and changes are summarized below.

- *Platform update:* BCAG v1.0 runs on Cube version 6.4.3 with GIS features. The updated BCAG v2.0 runs with the latest Cube version 6.5 Voyager, with no additional requirements of GIS features.
- *Model Run Set-up:* BCAG v1.0 was established in Cube platform with Cube Catalog. In this version, the script is upgraded to a master script and run with Cube Voyager. All the post-processing analysis are saved as separate scripts that can be run for model output summaries.
- *Recalibration:* Trip generation and trip distribution based on StreetLight data and traffic counts that account for travel behavior changes from pre-pandemic to 2022 conditions.
- *Land Use Inputs:* Updated base year 2018 data to represent new base year 2022.

- *New Trip Generation Land Use:* A new land use category is added to the model to account for CSU Chico on-campus student housing.
- *Traffic Analysis Zone (TAZ) split:* Model TAZs are refined for the known future projects, such as Barber Yard in City of Chico, and Tuscan Ridge in Butte County. Additional boundary adjustments and TAZ split are done for CSU Chico, and nearby zones.
- *Transportation Projects:* The transportation project list was updated to reflect the currently planned and programed projects. The model network input is updated from geodatabase network to Cube .net format master network, with details about the project year, number of lanes, posted speed, and facility type to accommodate for the future year model development.
- *Traffic Assignment Parameter*: The capacity adjustment link attribute is updated to correctly represent the capacity for auxiliary lanes. Additional changes are made to the capacity lookup table to better assign the traffic into the model network based on the capacity calculated using facility type, speed, and number of lanes.
- *Updated Traffic Counts:* 2022 traffic counts were collected to calibrate and validate the existing 2022 conditions, which considers the post COVID-19 and post-Camp Fire effects on traffic conditions. Additional Caltrans annual traffic counts and big data are used to cross-verify the collected traffic counts including at gateways.

The updates to the model reflect an existing 2022 condition, with changes that help to streamline model run procedure and ease the model use for project application.

What future updates would benefit the model for regional scenario planning?

- Refine economic factors at a more specific geography and forecast cross-classified socioeconomics for each scenario for both residential and non-residential land use types.
- Evaluate shifts in future assumptions such as autonomous vehicles, demographics, fuel price, and land use development patterns.
- Update the truck trip model to reflect the changes in local delivery and larger economic trends associated with internet shopping.
- Although the model passes reasonableness checks, and static and dynamic validation, it is recommended that the model be validated in the study area before it used for local-scale projects. This is especially important in the near-term during the recovery of Paradise, since land use development and travel patterns may change significantly in a shorter amount of time than occurred pre-Camp Fire.

Study Area

The model area for the BCAG TDF Model encompasses Butte County, which includes the cities of Chico, Paradise, Oroville, Biggs, and Gridley. **Figure 1** shows the BCAG TDF model area. To represent travel into and out of Butte County, the model also includes 20 "external gateways" at major roads that cross the county line.

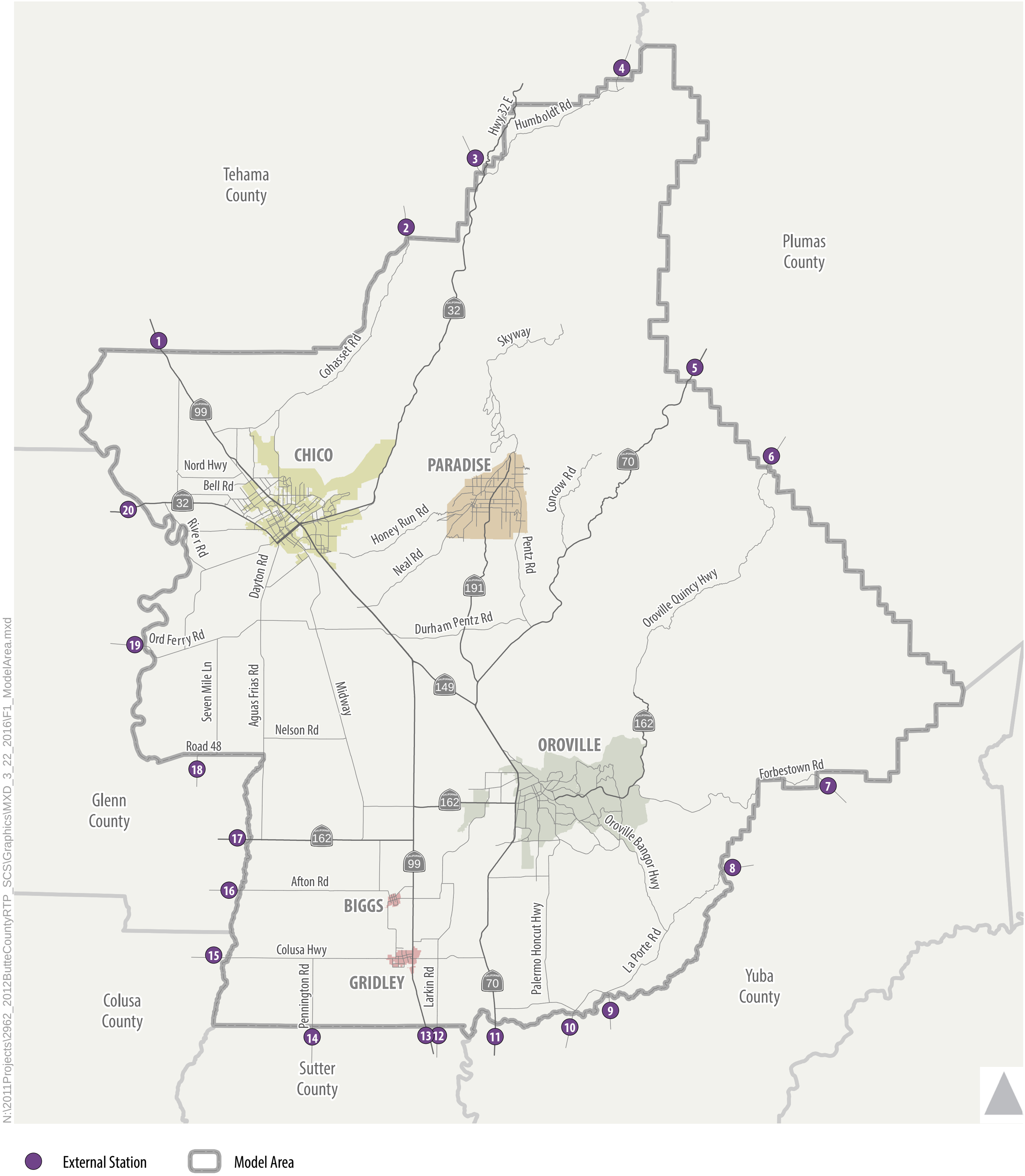


Figure 1

Model Area

2 Model Input Data

This section describes the data collection, review processes, and refinement for developing the model input data of the model.

Data Collection

A data collection effort was undertaken at the outset of the model development process. Data sources included the land use, roadway network, and traffic count database from BCAG, Caltrans Traffic Data Branch for highway counts, and CSU Chico for Geographic Information Systems (GIS) data. Additional data sources are listed below.

- 2021-2022 Census Bureau data
- Department of Finance (DOF) housing estimates
- California Statewide Household Travel Survey (CHTS), 2012
- Employment Development Department (EDD) employment estimates
- Longitudinal Employer-Household Dynamics (LEHD) data
- StreetLight Origin-Destination Mobile Device/Connected Vehicle Data (Big Data), 2019, 2022
- California Statewide Travel Demand Forecasting Model
- Bike and pedestrian facilities
- Transit routes, stops, and schedules
- Traffic counts
- Transit ridership

Traffic Analysis Zone System

TAZs represent geographic areas containing land uses that produce or attract trip ends. Travel demand models use TAZs to connect land uses to the roadway network. The TAZ boundaries for the BCAG model were developed from the Butte County parcel layer and closely nest within city boundaries in Butte County.

The TAZ boundaries from the previous model were maintained for this update, except for a few locations where TAZs were further split or boundaries modified to include additional details:

- Chico Barber Yard
- Tuscan Ridge (between Chico and Paradise near Skyway)
- CSU Chico Student Housing and adjacent CSU campus and residential areas
- Chico High School and adjacent residential areas

The TAZ identification numbering system, organized by plan area, is maintained with this update, as presented in **Table 1**. TAZ maps showing the zone boundary and zone number are shown in **Appendix A**.

Table 1: TAZ ID by Plan Area

Plan Area	Zone ID Range
Model Gateways	1-20 (21-99 Blank)
Biggs	100-122 (123-199 Blank)
Chico	200-532 (533-599 Blank)
Gridley	600-636 (637-699 Blank)
Oroville	700-816 (817-899 Blank)
Oroville – County	900-924 (925-999 Blank)
Paradise	1000-1117 (1118-1199 Blank)
Magalia	1200-1217 (1218-1299 Blank)
Unincorporated Butte County	1300-1559 (1560-1999 Blank)

Notes: Zone IDs that do not currently exist but are available for use in more detailed project analyses are noted in parentheses.
Source: Fehr & Peers, 2024.

The BCAG model TAZ system includes 929 zones in the model area covering Butte County, and 20 model gateways where major roadways provide access into the model area. The model gateways represent all major routes by which traffic can enter, exit, or pass through the model area. As noted in Table 1, there are blank zone IDs reserved for each plan area available for use in more detailed project analyses.

Gateways Data

The gateways dataset represents travel beyond the model boundary and contains the initial number of productions and attractions associated with the gateway locations by trip purpose. The home-based work productions and attractions are broken down by income category. **Table 2** below contains the location of all the gateways in the model.

Table 2: BCAG Model Gateway Location

Gateway TAZ	Location
1	Hwy 99 -north of Butter County Line
2	Cohasset Rd - north of Musty Buck Rd
3	Hwy 32 - north of Humboldt Rd
4	Humboldt Rd - north of Jonesville Rd
5	Hwy 70 - north of Butte County Line
6	Oroville Quincy Hwy - north of Haskins Valley Rd

Table 2: BCAG Model Gateway Location

Gateway TAZ	Location
7	Forbestown Rd - east of Reservoir Rd
8	La Porte Rd - northeast of Robinson Mill Rd
9	Loma Rica Rd - south of La Porte Rd
10	La Porte Rd - south of Butte County Line
11	Hwy 70 - south of Butte County Line
12	Larkin Rd - south of Butte County Line
13	Hwy 99 - south of Butte County Line
14	Pennington Rd - south of Rutherford Rd
15	Colusa Hwy - west of Cherokke Canal Rd
16	Afton Rd - west of Aguas Frias Rd
17	Hwy 162 - west of Butte County Line
18	Road Z - south of Road 48
19	Ord Ferry Rd - west of Hugh Baber Ln
20	Hwy 32 - west of Butte County Line

Source: Fehr & Peers, 2024.

Land Use Data

Land use data is one of the primary inputs to the BCAG model and this data is instrumental in estimating trip generation. The model's primary source of land use data is BCAG's residential, school, and commercial parcel and footprint datasets (maintained in a GIS format). Each database provides information on the existing level of development within the county and is aggregated to the model's TAZs. These databases are maintained by BCAG staff in association with CSU Chico. The land use data in the model is divided into several residential and non-residential categories. The BCAG model has 18 land use categories, which is consistent with the previous model except for the new land use type "CSU_HHSTU" representing the number of on campus student housing units. This new land use type is added to the model to better estimate travel activities near CSU Chico. Model land use categories and the detail description are described in **Table 3**.

Table 3: Model Land Use Categories

Land Use Type	Model Land Use ID	Units
Single Family Residential	SF_DU	Dwelling Units
Multi-Family Residential	MF_DU	Dwelling Units
Mobile Home Residential	MH_DU	Dwelling Units
Office	OFF_KSF	Thousand Square Feet
Medical Office	MED_KSF	Thousand Square Feet
Hospital	HOSP_KSF	Thousand Square Feet
Industrial	IND_KSF	Thousand Square Feet
Public/Quasi-Public	PQP_KSF	Thousand Square Feet
Park	PARK_AC	Acres
Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet
Region-Serving Retail	RRET_KSF	Thousand Square Feet
Hotels	HOTEL_RMS	Rooms
K-12 School	K12_STU	Students
University	UNIV_STU	Students
Community College	CC_STU	Students
Casino	CASINO_SLT	Slots
On Campus Student Housing	CSU_HHSTU	Dwelling Units

Note: CSU_HHSTU is estimated based on the number of students that live in on-campus housing. It is assumed as 2 persons per dwelling unit.
Source: Fehr & Peers, 2024.

Socio-Economic Data

The Socio-economic Data (SED) represents the number of households by housing type (single family, multi-family, mobile home, university student housing), number of residents, and household income level (low, medium, and high) for each TAZ. Additionally, the SED file contains the total square footage for the retail, regional retail, industrial, office, medical, hospital, and public/quasi-public land uses in addition to the number of hotel rooms, university students, community college students, K-12 students, park acreage, and the number of slot machines at the casinos.

Additional SED information includes household proportion by household type, size and income level. These SED proportion was updated in the 2020 RTP/SCS when BCAG model v1.0 was developed using U.S Census Bureau 2018 American Community Survey (ACS) 1-year Estimates for household inputs. When developing 2022 base year SED inputs, these values are preserved as the previous estimates with minor cleanups to calibrate to 2022 condition. These detail inputs are useful for project level analysis to better understand the change in trip generation by different land use combinations. This feature can also be used to evaluate different SCS strategies. The following section described the development of household information in the SED dataset for BCAG model v1.0 which are still valid for BCAG model v2.0.

The household information in the SED dataset was created by applying the household type proportions information from the U.S. Census Bureau. (U.S. Census Bureau (2018). American Community Survey 1-year Estimates. Retrieved from https://www.census.gov/data/developers/data-sets/acs-1year.html.) and applying them to the number of dwelling units in the land use datasets provided by BCAG. Through the application of these proportions the SED data contains the number of single family and multi-family dwelling units arranged by number of residents and household income category. The household income categories include:

1. Low: less than $35,000 a year
2. Medium: between $35,000 and $75,000 a year
3. High: greater than $75,000 a year

Additionally, the proportion of high, medium, and low-income jobs were calculated for each of the employment related land uses (retail, office, medical, etc.) for each TAZ. This input is currently not used in the model, but the details are retained in case future analysis is needed to further evaluate changes in travel behavior across different income groups for jobs. If employment attraction rate is available for each income group, those can be added into the model and the model would be able to estimate the trips based on employment by different income groups.

The U.S. Census Bureau Longitudinal Employer-Household Dynamics Quarterly Workforce Indicators (QWI)[1] dataset for 2018 was used to divide the employment land uses into the high, medium, and low-income categories. The average annual income was calculated for each North American Industry Classification System (NAICS) sector in Butte County using the QWI dataset. Each of the NAICS sectors were classified into a high (>$75,000), medium ($35,000 to $75,000), or low (<$35,000) category based on the estimated annual income. The NAICS sectors were then associated with one of the non-residential land use categories. **Table 4** below contains the relationship of NAICS sectors to the model land use with the corresponding income category. This relationship is currently preserved for both the 2022 base year and all forecast scenarios.

Table 4: Land Use Type by NAICS Sectors and Income Category

Land Use	Income Category	NAICS Sectors
Retail & Regional Retail	All Income Categories	44-45 Retail Trade, 72 Accommodation and Food Services
	Low (<$35,00)	44-45 Retail Trade, 72 Accommodation and Food Services

[1] U.S. Census Bureau. Longitudinal Employer-Household Dynamics, Quarterly Workforce Indicators (QWI). 2018. https://lehd.ces.census.gov/data/#qwi

[2] U.S. Census Bureau. Longitudinal Employer-Household Dynamics. LEHD Origin-Destination Employment Statistics (LODES). 2018. https://lehd.ces.census.gov/data/#qwi

Table 4: Land Use Type by NAICS Sectors and Income Category

Land Use	Income Category	NAICS Sectors
	Medium ($35,000 to $75,000)	-
	High (>$75,000)	-
Industrial	All Income Categories	21 Mining, 22 Utilities, 31-33 Manufacturing, 48-49 Transportation and Warehousing
	Low (<$35,00)	-
	Medium ($35,000 to $75,000)	21 Mining, 31-33 Manufacturing, 48-49 Transportation and Warehousing
	High (>$75,000)	22 Utilities
Office	All Income Categories	42 Wholesale Trade, 51 Information, 52 Finance and Insurance, 53 Real Estate Rental and Leasing, 54 Professional Scientific, and Technical Services, 55 Management of Companies and Enterprises, 56 Administrate and Support and Waste Management and Remediation Services, 71 Arts, Entertainment, and Recreation, 81 Other Services (except Public Administration)
	Low (<$35,00)	53 Real Estate Rental and Leasing, 56 Administrate and Support and Waste Management and Remediation Services, 71 Arts, Entertainment, and Recreation, 81 Other Services (except Public Administration)
	Medium ($35,000 to $75,000)	42 Wholesale Trade, 51 Information, 52 Finance and Insurance, 54 Professional Scientific, and Technical Services, 55 Management of Companies and Enterprises
	High (>$75,000)	-
Medical & Hospital	All Income Categories	62 Heath Care and Social Assistance
	Low (<$35,00)	-
	Medium ($35,000 to $75,000)	62 Heath Care and Social Assistance
	High (>$75,000)	-
Public/Quasi-Public	All Income Categories	22 Utilities, 61 Educational Services, 92 Public Administration
	Low (<$35,00)	-
	Medium ($35,000 to $75,000)	61 Educational Services, 92 Public Administration
	High (>$75,000)	22 Utilities

Source: Fehr & Peers, 2024.

The total number of employees by NAICS sector was calculated for each TAZ using the Workplace Area Summary datasets from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics Origin-

Destination Employment Statistics (LODES)[2] dataset. The proportion of employees in each NAICS sector was calculated for each Census Tract, and these values were allocated to the TAZs using a spatial join in ArcGIS. The TAZs were assigned the NAICS sector proportions based on which Tract their centroid fell within.

The employment totals were then used to estimate the proportion of employees in each NAICS sector. The NAICS sector proportions were then assigned to the TAZs using a spatial join in ArcGIS. TAZs were assigned the proportion values based on which Tract their centroid fell within. The sector proportions were then summarized to each land use and income category using the crosswalk detailed in Table 4. The same percentages file is currently preserved in all scenarios and can be changed for individual scenarios as appropriate. Due to the lack of trip generation rate data for different employment income groups, this function is preserved in the model but is not currently used. However, if employment attraction rates by employment income groups becomes available, this function can be activated in the future.

[2] U.S. Census Bureau. Longitudinal Employer-Household Dynamics. LEHD Origin-Destination Employment Statistics (LODES). 2018. https://lehd.ces.census.gov/data/#qwi

Roadway and Bicycle Network

The model network combines the roadway and bicycle networks into one master network file. The master network is inclusive of all roadway and bicycle network links that existed in 2022 plus those planned to be added through 2045. As described in the model update section, the model network input is updated from the geodatabase network to Cube .net format master network, with details about number of lanes, posted speed, and facility type for different scenarios. This update eliminates the potential issue in model run set up due to the compatibility issue of Cube and ArcGIS versions. The updated master network is also easier to edit and understand. Development of the master network included appropriately sorting and merging all the GIS data collected for the roadway and bicycle networks, reviewing current and historical aerial maps, and refining the network for implementation into the model structure. The model master network still maintains a high level of detail of the roadway and bicycle facilities. Compared to geodatabase format network, Cube .net format network loses the true shape of each facility from the GIS centerline files. However, that level of detail has not influenced the model's output estimates and forecasts.

The roadway and bicycle facilities included within the master network also focuses on the most used facility types. The master network facility classifications included in the model, consistent with the Butte County RTP/SCS, are described below.

Freeways

Freeways are high-capacity facilities that primarily serve longer distance travel. Access is limited to interchanges typically spaced at least one mile apart. State Route (SR) 70 and SR 99 are the major freeways in Butte County. Portions of SR 149 that connect SR 70 and SR 99 are also designed to meet freeway standards.

High Occupancy Vehicle Lanes

High Occupancy Vehicle (HOV) lanes are dedicated facilities on freeways with access restricted to single occupant vehicles (i.e., vehicles with only the driver, no passengers). These facilities can be restricted by time of day. Currently, no HOV lanes exist within Butte County; this facility type is included in the available options for possible future projects and modeling.

Expressways

Expressways are high-capacity facilities that primarily serve intermediate distance travel between intercity destinations. Access is limited, but not to the extent of freeways, and travel lanes may or may not be divided. Portions of SR 70, SR 99, SR 149, and Skyway are classified as expressways in Butte County.

Arterials

Roadway segments classified as Arterials are major roads that provide connections within cities, between cities and neighboring areas, and through the cities (cut-through traffic) of Butte County. Arterials in Butte County typically have one or two lanes in each direction, with travel speeds of 30-40 miles per hour (mph).

Examples of these arterials are East Avenue in Chico, Clark Road in Paradise, and Olive Highway in Oroville.

Collectors

Collectors (Major and Minor) are facilities that connect local streets to the arterial system and may also provide direct access to local land uses. Collectors generally provide two travel lanes and typically have a posted speed limit of 25 mph or greater. Examples of these collectors are Ceres Avenue in Chico, Nunneley Road in Paradise, and Myers Street in Oroville.

Local Streets

Local Streets primarily feed collector roads and generally provide two travel lanes with a posted speed limit of 25-30 mph. The model network focuses on freeways, arterials, and collectors but does include most of the local streets represented in the Butte County GIS centerline file to provide access from traffic analysis zones to the larger network. If a project application needs to assess local roadway performance, the model has been designed such that detail can be added to improve its sensitivity related to these facilities. These types of changes would typically be performed as part of a specific project application.

Transit Only Facilities

Transit Only facilities represent any lanes or dedicated travel-ways for transit use, restricted to all other vehicles. Currently no transit only facilities exist within Butte County; this facility type is included in the available options for possible future projects and modeling.

Bicycle Only Facilities

Bicycle Only facilities represent Class I multi-use off-street paths, or paved trails separated from roadways. These facilities restrict vehicle access and allow for shared use by cyclists and pedestrians. Class II bike lanes or Class III bike routes are represented along a roadway and identified separately based on the bicycle facility type attribute. The existing facilities were coded into the transportation network and coded with the appropriate functional type to prohibit use by other modes in both the accessibility calculation and in traffic assignment.

Pedestrian Facilities

Pedestrian facilities, such as sidewalks or multi-use paths, are not separately identified in this model. Access for pedestrians is assumed on all roadways and bicycle facilities, except for along freeways and expressways.

Table 5 shows each of the roadway and bicycle network facility types, along with the initial roadway speeds and capacities used for each roadway classification in the model.

Table 5: Model Roadway Facility Types

Facility Type ID	Facility Classification	Speed Range (MPH)	Lane Capacity Range (vphl)[1]
1	Freeway	55-65	1,750 – 2,000
2	Ramp: Freeway-to-Freeway	55-65	1,800
3	Ramp: Slip	20-45	1,500
4	Ramp: Loop	20-45	1,250
5	HOV	55-65	1,300 – 1,800
6	Expressway	35-55	800 – 1,100
7	Arterial	30-40	750 – 900
8	Collector	25-45	700 – 800
9	Local	25-30	600 – 700
10	Transit Only	25-55	NA
11	Bike Only	-	NA
100	Centroid Connector[2]	25	NA

1. vphl – vehicles per hour, per lane. These capacities are used for trip assignment purposes and do not reflect traffic operational throughput during peak hours, which is often lower especially if congestion occurs.
2. Centroid connectors are abstract representations of the starting and ending point of each trip, and therefore should have no capacity constraints

Source: Fehr & Peers, 2024.

The roadway and bicycle master network database include the network link attributes identified in **Table 6.** These attributes were checked using maps, aerial photographs, and other data provided by BCAG. In addition, the vehicle count data for the 309 roadway segments where traffic counts were collected in 2022/2023 are included at the relevant links for model validation.

Table 6: Master Network Link Variables

Attribute	Description	Example
A	A node	43
B	B node	11791
NAME	Roadway Name	SR 99
DISTANCE	Link distance in miles	3.56
DIST_ADJ	Link distance adjustment (e.g., at Model Gateways)	5
TERRAIN	Terrain (1=Flat, 2=Rolling, 3=Mountain)	1
PLAN_AREA	Planning area where link is located	Chico
DIR	Overall direction under all years (Two-Way = 0, One-Way=1). If any year is two-way, then this attribute is set to two-way.	0
USE	Indicate if the link is used in the model run	1
JURISDICTION	Political jurisdiction where link is located	Oroville
LANES_YEAR	Number of directional through vehicle travel lanes under specific year	1
SPEED_YEAR	Vehicle free-flow speed in miles-per hour under specific year	50
FACTYP_YEAR	Facility types under specific year. See Facility Types tab for codes	11
CAPADJ_YEAR	Vehicle lane capacity adjustment for Auxiliary Lane under specific year (factor for vehicle lane capacity adjustment: null, 0= no adjustment, 0.9 = adding 90% capacity)	0
TOLL_YEAR	Code used for cost for vehicles on toll facilities under specific year (i.e., VMT tax)	0
AREATYP_YEAR	Land use development affecting roadway capacity: Rural-1, Suburban-2, Urban-3, CBD-4	1
CNTID	Count ID	23
CNT_YR	Count Year	2017
DAY_CNT_TOT	Daily Count Two-Way Total	3,724
AM1_CNT_TOT	AM Peak Hour Count Two-Way Total	331
PM1_CNT_TOT	PM Peak Hour Count Two-Way Total	399

Source: Fehr & Peers, 2024.

In addition, the master network is also represented by nodes at the end of each roadway/bicycle link. The node attributes for the master network are presented in **Table 7**.

Table 7: Master Network Node Variables

Attribute	Description	Example
N	Node number	43
X	Y-coordinate of node in NAD_1983_StatePlane_California_II_FIPS_0402_Feet	6664944.483
Y	X-coordinate of node in NAD_1983_StatePlane_California_II_FIPS_0402_Feet	2248124.439

Source: Fehr & Peers, 2024.

Transit System

Rather than coding detailed transit routes, stops, and access, the transit system is represented by zones that have access and the frequency (in the form of headway) for adjacent transit routes. The TAZ dataset contains information on the peak and off-peak frequency of transit service for each TAZ. The frequency of transit service was determined for each of the TAZs using a GIS layer representing the bus stop locations throughout Butte County and 2022 B-Line schedules. TAZs that occurred within a quarter mile of a bus stop location were considered to be served by that bus stop. The frequency of peak and off-peak transit service was determined for each bus stop, and this information was assigned to TAZs that were within a quarter mile of the stop. If a TAZ was served by more than one bus stop, then the values from the bus stops with the most frequent service were assigned to the TAZ.

The 2022 transit frequency values were updated for future scenarios based on information provided by BCAG. Additionally, in the future scenarios, six micro-transit service areas are established in the City of Chico, the City of Oroville, and the Town of Paradise. A 15-minute headway was assumed for transit routes serving these micro-transit service areas. TAZ that either intersect with or fall within these six micro-transit service areas were identified and assigned the 15-minute headway. If a TAZ was served by stops on both fixed transit routes and within the micro-transit service areas, the most frequent service value was assigned to the TAZ.

As with most regional models, the transit system only includes routes and stops within Butte County. The primary reason is the sensitivity to transit of stop location relative to land uses outside of the travel model not being available or being too costly to obtain and model. Other common reasons for not including transit outside of the model region are the inability to accurately include number of stops, travel time, or transfers beyond the model boundary and the relatively low number of riders for a high level of effort.

Roadway Vehicle Counts

BCAG provided count data of vehicle traffic volumes on 309 roadway segments throughout the model area. Vehicle counts were conducted over a three-day period mid-week (Tuesday through Thursday) in Year 2022 and 2023. The data also includes breakdown by travel speed and number of heavy vehicles. The roadway vehicle count data was used for validation of the base year model.

Transit Routes and Ridership

BCAG provided transit stop, route, and ridership information for B-Line Transit, the local and regional transit service provider in the base year 2022. BCAG also provided the list of future transit projects as identified in the 2024 RTP and previous 2020 RTP.

2012 California Household Travel Survey (CHTS)

The California Household Travel Survey (CHTS) was conducted in 2012 and 2013 in 58 counties.[3] The CHTS is a combination of travel diary and GPS data, which allowed for under-reported information such as walking trips, non-home-based trips, and stops along a long trip. The CHTS is publicly available on nrel.gov at a granular level.

2012 CHTS data was previously summarized and used to validate base year 2018 of the BCAG Model v1.0 for 2020 RTP/SCS. As mentioned in the model limitation section, no additional CHTS data has been published since 2012/2013. The same CHTS data is used when calibrating and validating the updated base year 2022 for 2024 RTP/SCS.

Preparation and Cleaning of CHTS Data

The publicly available version of the 2012 CHTS required a substantial amount of preparation, including re-weighting, before it was suitable for model development. Fehr & Peers has done extensive data preparation, including statewide and county weights, to create tailored summaries. Examples are residential VMT, trip length, and mode share summaries. These can be found in **Appendix B.**

Identification of Trip Purposes

The 2012 CHTS data does not describe trip purposes directly; instead, it contains a "place" file whose attributes include a listing of up to three activities the respondent participated in at that place. A small list of place purposes was distilled from this activity information: HOME, WORK, COLLEGE, K12, SHOP, or OTHER. In this project, we summarize total person trips starting and ending within Butte County for all trip purposes.

Estimation of Survey Weights

Surveys capture the characteristics of an entire population by randomly sampling a small proportion of the population. Often, a perfectly random sample is hard to achieve — some groups are difficult to survey and are under-represented, other groups are over-represented. To balance this bias, estimated sample weights "reshape" the sample. Fehr & Peers estimated household sample weights for the CHTS to balance the survey sample to match county-level percentages for several variables as reported in the 2012 ACS 5-year estimates (U.S. Census Bureau (2018). American Community Survey 5-year Estimates. Retrieved from https://www.census.gov/data/developers/data-sets/acs-5year.html.). Listed below are variables used as controls for the re-weighting.

- Household size (one to seven or more).
- Household income (nine income categories).
- Number of workers per household (zero to three or more).

[3] https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics/ca-household-travel-survey

- Number of vehicles owned per household (zero to four or more).
- Household residential unit type (three categories).
- Household size (one to five or more) cross-classified by household income (five categories).
- Household size (one to five or more) cross-classified by number of vehicles per household (zero to four or more).
- Household size (one to five or more) cross-classified by number of workers per household (zero to three or more).

The survey weights must be correctly applied to yield accurate summaries. There are three types of weights included with the cleaned CHTS data:

- Household-level weights (hhweight, hhexpweight, and hhexpweight_weekday)
- Trip-level weights (tripweight, tripexpweight, and tripexpweight_weekday)
- Trip correction factor (tcf)
- The relationship among the three weighting factors is:
    - *Tripweight = hhweight * tcf*
    - *Tripexpweight = hhexpweight * tcf*
    - *Tripexpweight_weekday = hhexpweight_weekday * tcf*

To use CHTS data accurately, one or more of these weights must be applied. A trip weight is used to weight trips relative to one another, and it is useful for computing percentages. At the same time, the tripexpweight factors provide estimates of the total number of trips. In this project, we implemented the tripexpweight_weekday weighting factor.

Place Type

In addition to locating households and trip ends using census tracts, Census Designated Places (CDPs), and counties, each household location and a trip end is assigned a place type category. The place type is based on the number of jobs and the working-age population accessible from the household or trip end.

CHTS Summaries for Validation

The CHTS data were summarized for trips starting and ending within Butte County for model validation purposes. The type of information from the CHTS used for validation is listed below.

- Mode share
- Mode share by trip purpose
- Total Households (for comparison and statistical purposes)
- VMT per household (and by trip purpose) for validation
- Daily vehicle trips per household (and by trip purpose) for trip generation
- Average vehicle trip length (and by trip purpose) for validation
- Average person trip length (and by trip purpose) for validation

- VMT and Person Miles Traveled (PMT) per capita/household for validation

The “simple” and “flat” summaries contain one record per geography which is suitable for joining to GIS. The “simple” summary includes a smaller number of metrics, while the “flat” summary contains many more details. The “filterable” summary provides many records per geography and is viewable in Excel.

In this project, we created a summary of trips that only start and end within Butte County. The methodology is summarized below:

- The code is CHTS_nonhighway_validation.R
- The trip unit is "personTrips"
- Region name countyList is set for 6007 which is Butte County
- Input files are households_clean.csv and trips_clean.csv for households and trips variables, respectively.
- For the home and work tracts, the geography lookup variable is set to geoglookup_full.csv
- The output is written in the CSV format.

A high-level summary of the survey records is shown below for both the SACOG region and Butte County. Detailed tables with metadata are in **Appendix B**.

Table 8: CHTS High-Level Summary

Code	Name	Type	lookup	Total Households	Total person trips
3	SACOG	region	SACOG region	816,939	6,803,865
6007	Butte	county	Butte County	85,074	664,437

Source: Fehr & Peers, 2024.

Interregional Travel

The travel model generates total person and commercial vehicle trips that travel completely internal to Butte County, and interregional trips that travel to, from, and through Butte County. These trip types are referenced as follows in the remainder of this document.

- Internal-internal (I-I) trips that originate and terminate within the model area.
- Internal-external (I-X) trips that originate within but terminate outside of the model area.
- External-internal (X-I) trips that originate outside and terminate inside of the model area.

To estimate base and future year data for the interregional trips, the California Statewide Travel Demand Model (CSTDM), California Statewide Freight Forecasting Model (CSFFM), and mobile device/connected vehicle data were used. The mobile device/connected vehicle trip estimates were obtained from StreetLight data to refine the I-I, I-X, X-I, and gateway trips for the base year (i.e., recognizing post-pandemic travel patterns), and the growth from the CSTDM and CSFFM were applied to the refined base year interregional data.

As discussed in the Data Collection section, StreetLight data from 2019 and 2022 were used to analyze changes in travel behavior in Butte County post-pandemic. The data indicate that Butte County's internalization rate increased from 88% in 2019 to 89% in 2022, with the most notable growth in home-based work (HBW) trips, which rose from 88% to 91%. However, while HBW trips accounted for 24% of total I-X and X-I trips in 2019, this percentage declined to 19% in 2022. In contrast, home-based other (HBO) and non-home-based (NHB) I-X and X-I trips both saw an increase of 2% to 3%.

California Statewide Travel Demand Model

The 2020 RTP/SCS model utilized the CSTDM to estimate base year and future year interactions with the gateways and for through trips. Since the latest version of the model has not been released, the same through trips and interregional factors from the 2020 RTP/SCS model were used as the starting point for calibration and then refined based on mobile device/connected vehicle data, count data, and the updated trip generation for passengers and commercial vehicles. Similar to the CSTDM forecast for passengers, the CSFFM was used to estimate interregional commercial vehicle travel.

Mobile Device Data (Big Data)

Travel patterns are typically expressed in terms of origins and destinations – origins being locations where trips begin, and destinations being locations where trips end. In its most basic form, a travel pattern is an origin-destination pair that represents a direct trip from one location to another. Work commute trips are among the most common origin-destination pairs, typically from a residence to a place of employment in the morning, and then back to home at the end of a workday.

StreetLight Data aggregates anonymized location-based data from smartphones, car/truck navigation systems, and connected vehicles. The data is used to estimate the distribution and quantity of trips between or through geographic areas. Conventional approaches to estimating trip distribution rely on travel demand models. The use of StreetLight data, however, casts a snapshot of origin-destination information grounded in the actual travel behavior of roadway users. The use of GPS data was to capture the auto travel separate from the commercial vehicle travel and was appropriate for distribution of internal-external (IX) and external-internal (XI) personal and commercial vehicles (medium and heavy trucks), and external-external (XX) personal and commercial vehicles since the model does not reflect interregional transit.

Two different sets of StreetLight data were used in the model calibration and validation process to develop the base year 2022 conditions for the BCAG model. The first set of data is similar to what was used for the 2020 RTP/SCS BCAG model v1.0 base year scenario, including IX, XI, and XX trip characteristics from January to April 2022 during the post-pandemic period. Given the rapid changes in travel behavior over the past three years (2019–2022) due to the pandemic, additional analysis was conducted using data from 2018 (pre-Camp Fire) and 2019 (post-Camp Fire, pre-pandemic). Comparing data from these three periods provides a deeper understanding of changes in travel behavior and helps establish more accurate calibration targets.

The second set of StreetLight data is a unique dataset released specifically for VMT analysis, including aggregated sample trip counts by trip purpose for March and April 2022. This new data, combined with CHTS data, was used to estimate vehicle trip generation rates and travel distances, further refining the calibration and validation of the base year 2022 conditions.

Travel Cost

In addition to travel time, the cost of travel influences auto ownership, trip distribution, mode choice, and route choice. Although the model allows for a link-based cost, BCAG does not have existing or planned roadway user fees based on distance traveled or for using specific roadways. If such facilities are expected in the future, this feature should be calibrated prior to use.

Parking Cost

The average parking cost per trip can be stored as a zonal attribute and can be used in both trip distribution and mode choice. However, this feature has not been activated in the model.

Auto Operating Cost

Auto operating costs are a major influence on travel. Auto operating costs include fuel price, maintenance costs, and tire replacement costs. The California Air Resources Board (CARB) has developed a spreadsheet that takes these factors into account for each MPO and for predetermined evaluation years. The spreadsheet was used to develop costs for the years corresponding to the base year and future scenario years and the model interpolates the values for other model years. **Table 11** shows the presumed auto operating costs applied in the model. The detailed auto operating costs estimates can be found in **Appendix C**.

Table 9: BCAG Auto Operating Costs

Year	Cost[1]
2022	$0.2138
2035	$0.1892
2045	$0.1825

1. Costs represented in 2018 dollars. The model input file is in cents and contains interpolated values for years between those listed in the table.

Source: California Air Resources Board spreadsheet tool, 2020.

Accessibility

The BCAG TDF model includes two accessibility pre-processors. These are Python scripts, operating on the input TAZ and network shapefiles to produce accessibility metrics.

- Intersections.py produces a count of the number of intersections per TAZ.
- RoadwayMiles.py produces the sum of walkable network miles.

These script outputs, in data base format (DBF), are used during the model input preparation stage to calculate the accessibility metrics shown in **Table 10** at the TAZ level.

A third input file, VMTseed, contains an estimate of the average commuting VMT generated per worker in the TAZ. The starting estimates can be approximate because this estimate is updated throughout the model process.

During the input preparation phase of the model, TAZ-level accessibility metrics and built environment ("D variable") metrics are produced. These metrics are updated as the model runs through its feedback loops. Some of the accessibility metrics are implemented later in the model; others are provided as model outputs. Table 10 below shows key accessibility metrics used in the model.

Table 10: Accessibility Metrics

Metric	Description	Where used
ATYPE	Place Type categorization to three categories based on trip generation difference. (Explained under Trip Generation Rate Section)	Trip Generation
LOG_EMPD	Log of employment density (jobs per developed acre)	Auto Ownership, Mode Choice
INTDEN	Intersection density (intersections per square mile)	Auto Ownership, Mode Choice
EMP_30TRN	Jobs within 30 minutes by transit	Auto Ownership, Mode Choice
COMMUTECOST	Average annual commute cost	Auto Ownership

Source: Fehr & Peers, 2024.

Data Quality Checks

The input data were reviewed and compared using statistical methods or reasonableness checks prior to calibration and validation of the model. Survey data were evaluated statistically to determine if there was a sufficient sample to use for calibration or validation, resulting in the combination of multiple sources of data for calibration to provide a larger data set and using Butte County only data for validation at an appropriate level to match the samples. Traffic count data were compared between the multiple days to identify potential outliers. If there were outliers nearby locations were compared to determine which count was most reasonable to use as a single day observation, while those without outliers were averaged. Roadway, transit, and bike/pedestrian networks and TAZ boundaries were reviewed visually using color themed maps. Land use control totals by category and totals by jurisdiction were reviewed. Transit system data were compared to published route maps and schedules. Big data was reviewed and cross-checked against the other data sources mentioned above to confirm the reasonableness.

3 Model Estimation, Calibration, and Reasonableness Checks

This section describes the model estimation, calibration, and reasonableness checks performed during the update to the model.

Model estimation is the term used to describe the process by which model inputs (e.g., trip rates, friction factors, I-X/X-I percentages) are derived from sources like survey and count data for application in the model calculations.

Model calibration refers to the adjustment of the model parameters to better replicate observed travel behavior and traffic volumes in the region. Calibration improves model accuracy and is a required step to ensure that the model reflects existing data, is sensitive to the type of projects it will be applied and meets the validation criteria described in the following section.

Reasonableness checks refer to testing of individual model components to ensure they closely replicate observed data prior to the result being used in a downstream process.

The sections below describe the calibration from the updated base year 2022 model followed by the resulting reasonableness check for each model component.

Trip Generation and Trip Balancing

Trip generation relates to the number of person trips going to/from a site based on the type of land use intensity and diversity of that particular site. With the functionality of person trips rather than total vehicle trips, separating home-work trips by income for the household and salary for the worker allowed for matching of home and work location.

The person trip generation portion of the model follows the following process:

- Daily person trip generation rates for each land use type
- Trip purpose percentages of daily person trip generation rates
- Interregional (IX and XI) trip percentages by trip purpose
- Trip productions and attractions balanced by trip purpose and income level

Trip Generation Rates

When updating the model for 2020 RTP/SCS, land use, demographic, and socio-economic factors in a cross-classified formulation. The same cross-classified formulation is used in person trip generation rate for 2024 RTP/SCS and is developed starting with the 2020 RTP/SCS rates. The following section described the change to person trip generation rates for base year 2022 condition.

Place Type

Place type is defined based on different trip generation rates within the BCAG region. As mentioned in the previous section, StreetLight VMT data is used to estimate the change in vehicle trip generation rates for all Census Block Groups (CBG) within the region, and three place types are defined based on the trip generation rate for aggregated CBGs. The three place types are listed in **Table 11** below.

Table 11: Place Types

Place Type Category	Alternate Name	Description of Place Type based on Trip Generation Rate
1	AType1	All remaining TAZs, applied a 3% higher residential trip generation rate and 1% higher non-residential rate comparing to County Average
2	AType2	Magalia, Biggs, Gridley, and Southwest of Butte County, applied a 5% lower residential trip generation rate and 1% higher non-residential rate comparing to County Average
3	Atype3	Northeast and Southeast of Butte County, applied a 12% lower residential trip generation rate and 6% lower non-residential rate comparing to County Average

Source: Fehr & Peers, 2024.

Residential Person Trip Generation

The previous update of the BCAG model for the 2020 RTP/SCS enhanced the residential trip generation sub-model from one that relied exclusively on land use as the independent variable to one that considered land use, demographic, and socio-economic factors in a cross-classified formulation. The trip generation rates for single family and multi-family homes were expanded to represent the different trip generation characteristics of a variety of households within Butte County. The cross-classification for residential land use is based on household size (1, 2, 3, or 4+) and household income (<$35K, $35K-$50K, $50K-$75K, >$75K).

Table 12 contains the cross-classified residential vehicle trip rates for occupied single family, multi-family, mobile homes and College on-campus student housing. The rates were estimated using the 2012 CHTS data and adjusted during the model calibration with StreetLight data and Census 2022 household estimations. This CHTS survey was conducted statewide and provides a complete summary of daily household trip making.

Table 12: Residential Daily Person Trip Generation Rates

Place Type	Household Type	Household Size	Income			
			< $35K	$35K – $50K	$50K – $75K	> $75K
1	Single Family	1	3.21	3.21	3.85	3.85
		2	8.39	8.39	9.07	11.79
		3	8.39	8.39	9.07	11.79
		4	12.15	12.15	13.31	14.39
		5	18.08	18.08	19.37	21.96
	Multi-Family	1	1.80	1.80	3.07	3.07
		2	5.10	5.10	5.52	7.18
		3	5.10	5.10	5.52	7.18
		4	7.79	7.79	8.10	8.76
		5	11.00	11.00	11.78	13.37
	Mobile Home	1	1.64	1.64	2.79	2.79
		2	4.64	4.64	5.02	6.52
		3	4.64	4.64	5.02	6.52
		4	7.08	7.08	7.36	7.96
		5	10.00	10.00	10.71	12.15
	College On-Campus Housing	1	1.64	1.64	2.79	2.79
		2	4.64	4.64	5.02	6.52
		3	4.64	4.64	5.02	6.52
		4	7.08	7.08	7.36	7.96
		5	10.00	10.00	10.71	12.15
2	Single Family	1	2.97	2.97	3.55	3.55
		2	7.74	7.74	8.37	10.88
		3	7.74	7.74	8.37	10.88
		4	11.21	11.21	12.28	13.28
		5	16.67	16.67	17.86	20.25
	Multi-Family	1	1.66	1.66	2.83	2.83
		2	4.70	4.70	5.09	6.62
		3	4.70	4.70	5.09	6.62
		4	7.18	7.18	7.47	8.08
		5	10.15	10.15	10.87	12.33
	Mobile Home	1	1.51	1.51	2.57	2.57
		2	4.28	4.28	4.63	6.02
		3	4.28	4.28	4.63	6.02
		4	6.53	6.53	6.79	7.35

Table 12: Residential Daily Person Trip Generation Rates

Place Type	Household Type	Household Size	Income			
			< $35K	$35K – $50K	$50K – $75K	> $75K
		5	9.22	9.22	9.88	11.21
	College On-Campus Housing	1	1.51	1.51	2.57	2.57
		2	4.28	4.28	4.63	6.02
		3	4.28	4.28	4.63	6.02
		4	6.53	6.53	6.79	7.35
		5	9.22	9.22	9.88	11.21
3	Single Family	1	2.75	2.75	3.29	3.29
		2	7.17	7.17	7.75	10.08
		3	7.17	7.17	7.75	10.08
		4	10.38	10.38	11.37	12.30
		5	15.44	15.44	16.55	18.76
	Multi-Family	1	1.54	1.54	2.62	2.62
		2	4.36	4.36	4.72	6.13
		3	4.36	4.36	4.72	6.13
		4	6.65	6.65	6.92	7.48
		5	9.40	9.40	10.07	11.42
	Mobile Home	1	1.40	1.40	2.38	2.38
		2	3.96	3.96	4.29	5.58
		3	3.96	3.96	4.29	5.58
		4	6.05	6.05	6.29	6.80
		5	8.54	8.54	9.15	10.38
	College On-Campus Housing	1	1.40	1.40	2.38	2.38
		2	3.96	3.96	4.29	5.57
		3	3.96	3.96	4.29	5.57
		4	6.05	6.05	6.29	6.80
		5	8.54	8.54	9.16	10.38

Note: To account for land use density, in addition to the trips by income and household size, the total households per zone generate an additional 0.93 trips per household.

Source: Fehr & Peers, 2024

Non-Residential Person Trip Generation

The primary source for non-residential person trip generation rates in the model was the 2016 RTP/SCS model, with the vehicle trips converted to person trips using the mode split and persons per vehicle from the 2012 CHTS. The 2016 RTP/SCS model was based on ITE 9th Edition Trip Generation[4] vehicle trip generation rates, which contains national averages of vehicle trip generation rates for a variety of land uses in what are generally suburban locations. The 2016 RTP/SCS model vehicle trip rates based on the 9th Edition were used rather than starting with rates from the 11th Edition since the travel model rates had been previously calibrated to reflect travel in Butte County, unlike the national data provided directly by ITE. The rates from the 2016 RTP/SCS model were calibrated for major non-residential land uses such as prominent retail centers and institutions within Butte County using a methodology similar to that explained above for residential uses. **Table 13** displays the final non-residential trip rates.

Table 13: Non-Residential Daily Person Trip Generation Rates

Place Type	Land Use Type	Model LU	Units	Person Rate
1	Office	OFF_KSF	Thousand Square Feet	18.05
	Medical Office	MED_KSF	Thousand Square Feet	13.47
	Hospital	HOSP_KSF	Thousand Square Feet	4.07
	Industrial	IND_KSF	Thousand Square Feet	11.81
	Public/Quasi-Public	PQP_KSF	Thousand Square Feet	27.10
	Park	PARK_AC	Acres	1.84
	Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet	43.16
	Region-Serving Retail	RRET_KSF	Thousand Square Feet	54.74
	Hotels	HOTEL_RMS	Rooms	4.10
	K-12 School	K12_STU	Students	3.30
	University	UNIV_STU	Students	1.65
	Community College	CC_STU	Students	1.65*
	Casino (Special Generator)	CASINO_SLT	Slots	4.41
2	Office	OFF_KSF	Thousand Square Feet	18.05
	Medical Office	MED_KSF	Thousand Square Feet	13.47
	Hospital	HOSP_KSF	Thousand Square Feet	4.07
	Industrial	IND_KSF	Thousand Square Feet	11.81
	Public/Quasi-Public	PQP_KSF	Thousand Square Feet	27.10
	Park	PARK_AC	Acres	1.84
	Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet	43.16

[4] *Trip Generation* (9th edition.). (2012). Washington, D.C.: Institute of Transportation Engineers.

Table 13: Non-Residential Daily Person Trip Generation Rates

Place Type	Land Use Type	Model LU	Units	Person Rate
	Region-Serving Retail	RRET_KSF	Thousand Square Feet	54.74
	Hotels	HOTEL_RMS	Rooms	4.10
	K-12 School	K12_STU	Students	3.30
	University	UNIV_STU	Students	1.65
	Community College	CC_STU	Students	1.65*
	Casino (Special Generator)	CASINO_SLT	Slots	4.41
3	Office	OFF_KSF	Thousand Square Feet	17.48
	Medical Office	MED_KSF	Thousand Square Feet	13.14
	Hospital	HOSP_KSF	Thousand Square Feet	3.98
	Industrial	IND_KSF	Thousand Square Feet	11.64
	Public/Quasi-Public	PQP_KSF	Thousand Square Feet	26.88
	Park	PARK_AC	Acres	1.84
	Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet	43.05
	Region-Serving Retail	RRET_KSF	Thousand Square Feet	54.59
	Hotels	HOTEL_RMS	Rooms	4.04
	K-12 School	K12_STU	Students	3.30
	University	UNIV_STU	Students	1.65
	Community College	CC_STU	Students	1.65*
	Casino (Special Generator)	CASINO_SLT	Slots	4.38

* In the model, Community College students and University students are combined together with the same person rate.

Source: Fehr & Peers, 2024.

Commercial Truck Trip Generation

Along with generating person trips rather than total vehicle trips, the commercial truck trips were separated from passenger travel. The trip generation is based on the CSFFM and calibrated to local conditions. The trip generation for aggregated non-residential sectors is shown below in **Table 14**. No additional adjustments are made for commercial truck trip generation for 2024 RTP/SCS.

Table 14: Commercial Truck Daily Trip Generation

Model Industry/Commodity	NAICS 2007	Daily Trip Rate
Total Households	NA	0.61
Total Employees	NA	0.52
Ag/Farm/Fish	11	0.16
Mining	21	0.20
Construction	23	0.20
Manufactured Products	31-325	0.25
Manufactured Equipment	326-33	0.17
Transportation/Communication/Utilities	22, 48 ,492, 493, 51	0.17
Wholesale	42	0.17
Retail Trade	44-45	0.17
Finance, Insurance, Real Estate, Service	52-56, 62, 71, 72, 81	0.07
Education/Govt	491, 61, 92	0.07

Source: Fehr & Peers, 2024.

Person Trip Purposes and Income

Trip generation rates are initially defined for total trips and later split by trip purpose. Each trip has two ends, a "production" and an "attraction." By convention, trips with one end at a residence are defined as being "produced" by the residence and "attracted" to the other use (workplace, school, retail store, etc.), and are called "Home-Based" trips. Trips that do not have one end at a residence are called "Non-Home-Based" trips.

There are seven primary trip purposes used in the BCAG model.

- *Home-Based Work (HBW):* trips between a residence and a workplace, separated into low, medium, and high to improve the commute location by matching jobs and household income
- *Home-Based Shop (HBS):* trips between a residence and a store
- *Home-Based Other (HBO):* trips between a residence and any other destination
- *Work*-Based Other (WO): trips between a workplace and any other destination except a residence
- *Other-Based Other (OO):* trips that do not begin or end at a residence or workplace, such as traveling from a park to a restaurant, or from a retail store to a bank
- *School (HK):* trips to and from a school (K-12)
- *University (HC):* trips to and from a community college or university

The 2012 CHTS data and 2022 StreetLight data were used to determine the appropriate proportion of trips that represent each purpose. The University trip purpose category was added for 2020 RTP/SCS to better represent the travel patterns of students attending CSU Chico and Butte College.

Interregional (IX and XI) Trip Percentages

The interregional factors are based on CHTS for each trip purpose and refined based on StreetLight data to have an improved geographic sensitivity. Each TAZ incorporates an IX and XI percentage for each trip purpose.

Internal/External Trips Interactions

One of the important inputs to a travel model is an estimate of the amount of travel between the study area and neighboring areas outside the model. These I-X/X-I trips have one trip end in the county with the other trip end outside the county. The I-X/X-I percentages were initially estimated for each model trip purpose using the 2012 CHTS data. These estimates were then refined using the county's external station counts. **Table 15** summarizes the proportion of IX and XI trips by purpose for the base year.

Table 15: Percent of Trips by Purpose That are Interregional

Purpose	Model	StreetLight	CHTS[1]
Home-Based Work (HBW)	10.5%	7.7%	15.9%
Home-Based Other (HBO)	8.2%	10.8%	8.8%
Non-Home-Based (NHB)	8.0%	10.3%	11.4%

Note:
[1] The CHTS estimates are from 2012 and are no longer a reasonable benchmark for calibration. Instead, they are useful for understanding how interregional has changed due to major factors such as the pandemic and the shift to more telework and internet shopping.
Source: Fehr & Peers, 2024.

After the number of I-X/X-I trips are estimated, these trips are distributed to the stations around the perimeter of the model area using external station weights. External station weights are based on counts collected at each external station (these are roadway segments at the border of the model area). The number of through trips at each station was subtracted from the count and the remainder was filled in by I-X/X-I trips estimates. The resulting external station weights are presented in **Table 16**.

Table 16: External Station Weights

ID	Description	Weight
1	Hwy 99 – north of Butte County Line	20.40%
2	Cohasset Rd – north of Musty Buck Rd	0.13%
3	Hwy 32 – north of Humboldt Rd	0.66%
4	Humboldt Rd – north of Jonesville Rd	0.01%
5	Hwy 70 – north of Butte County Line	1.45%
6	Oroville Quincy Hwy – north of Haskins Valley Rd	0.13%
7	Forbestown Rd – east of Reservoir Rd	0.24%
8	La Porte Rd – northeast of Robinson Mill Rd	0.18%
9	Loma Rica Rd – south of La Porte Rd	1.01%
10	La Porte Rd – south of Butte County Line	1.61%
11	Hwy 70 – south of Butte County Line	18.80%
12	Larkin Rd – south of Butte County Line	5.50%
13	Hwy 99 – south of Butte County Line	21.59%
14	Pennington Rd – south of Rutherford Rd	0.43%
15	Colusa Hwy – west of Cherokee Canal Rd	1.05%
16	Afton Rd – west of Aguas Frias Rd	0.18%
17	Hwy 162 – west of Butte County Line	2.59%
18	Road Z – south of Road 48	0.40%
19	Ord Ferry Rd – west of Hugh Baber Ln	5.39%
20	Hwy 32 – west of Butte County Line	18.26%

Source: Fehr & Peers, 2024.

Through Trips

Through trips (also called external-external, or X-X trips) are trips that pass through the study area without stopping inside the study area. The major flows of through traffic in Butte County use Hwy 99, Hwy 70, and Hwy 32, with lower volumes of through traffic using other arterials. The CSTDM was the starting point for passenger vehicle trips and the CSFFM for commercial vehicles. The size of these flows was calibrated using StreetLight data and traffic counts collected as part of the model update.

Trip Productions and Attractions Balancing

Local trips (internal-to-internal, or I-I) are trips that both start and end in the model area. One of the basic requirements of any travel model is that the total number of local trips produced is equal to the total number of local trips attracted. It is logically assumed that if a journey begins, it must have an ending somewhere else. If the total productions and attractions are not equal, the model will typically adjust the attractions to match the productions, thus ensuring that each departing traveler finds a destination. While it is never possible to achieve a perfect match between productions and attractions prior to the automatic balancing procedure, a substantial mismatch in one or more trip purposes may indicate an error in the model land use inputs or trip generation.

Table 17 summarizes the local trip productions and attractions from the model for each trip purpose, prior to the application of the automatic balancing procedure. Guidelines published by the Travel Model Validation and Reasonableness Checking Manual [5] and the National Cooperative Highway Research Program (NCHRP) Report 716 [6] suggest that, prior to balancing, the number of productions and attractions should match to within plus or minus 10% (i.e., the production-to-attraction ratio should be within the range of 0.90 to 1.10). The results shown in Table 17 indicate that the 2022 base year model meets the published guidelines for all trip purposes.

Table 17: Person Trip Production to Attraction Ratios by Purpose

Trip Purpose	Production/Attraction
Home-Based Work (HBW)	1.00
Home-Based Shop (HBS)	1.00
Home-Based Other (HBO)[1]	1.03
Non-Home-Based (NHB)	1.03
Total	1.02

Note:
[1] The trip purposes listed are the broad categories applied in most every travel model. The more specific BCAG trip purposes are subsets of these broader trip purposes and have been aggregated here for ease of comparison. The School, Casino, and University purposes are subsets of the HBO trip purpose.
Source: Fehr & Peers, 2024.

Trip Generation Sensitivity

The BCAG TDF model contains enhancements to better capture local trip making characteristics and provides the ability to test certain policy options for future development scenarios. These features include adjustments for residential and non-residential vacancy rates and adding sensitivity for aging population, the cost of travel, smart growth development, and changes to the transit system.

[5] *Model Validation and Reasonableness Checking Manual* (2nd edition). (2001). Washington, D.C.: U.S. Dept. of Transportation, Federal Highway Administration, Federal Transit Administration, Assistant Secretary for Transportation Policy.

[6] *Travel Demand Forecasting: Parameters and Techniques* (Report 716). (2012). Washington, D.C: Transportation Research Board.

Vacancy Rates

The trip generation sub-model has the ability to reflect varying levels of occupancy for residential and non-residential buildings. However, for this update, BCAG staff elected to provide land use information already adjusted for vacancy. Therefore, the vacancy rate adjustment factors were set to 1.0.

Aging Population

It has long been recognized that households with older residents generate fewer vehicle trips than households where the residents are younger. The reason behind the reduced trip generation is generally thought to be due to the reduced number of work trips, fewer activities requiring travel, and the fact that a portion of this age group cannot drive.

For BCAG model, there is an age of head of household adjustment that applies for each trip purpose and multiplies by the calibrated trip rate to test for potential increases or decreases in travel relative to age. The factor is currently set at 1.0 to represent the 2012 CHTS data as calibrated to represent 2022 conditions in Butte County.

Trip Distribution (Gravity Model)

Once the trip generation step has estimated the number of trips that begin and end in each zone, the trip distribution process determines the specific destination of each originating trip. The destination may be within the zone itself, resulting in an intra-zonal trip. If the destination is outside of the zone of origin, it is an inter-zonal trip. Inter-zonal trips consist of II, IX, and XI trips.

The trip distribution model uses a gravity model equation to distribute trips to all TAZs. This equation estimates an accessibility index for each TAZ based on the number of attractions in each TAZ and the travel time between TAZ. Each attraction TAZ is given its share of productions based on its share of the accessibility index. This process applies to the I-I, I-X, and X-I trips. The X-X trips are added to the trip matrix prior to final assignment.

The gravity model uses the multimodal networks, matches household income locations with job locations by salary, allows for IX and XI trips to vary by individual zone rather than by land use type and trip purpose, and includes more sensitivity to gateway attractiveness by trip purpose. The trip distribution model also takes into account the impact of attractiveness based on vehicles availability to a household, and the accessibility of a location.

Friction Factors

Friction factors, also known as travel time factors, are used in calculating the relative attractiveness of each destination zone based on the travel time between TAZs and the number of potential origins and destinations in each TAZ. These factors are used in the trip distribution stage of the model. The BCAG model friction factors are based on data reported in national modeling reference documents such as

Travel Estimation Techniques for Urban Planning, NCHRP 365 [7] and are updated for base year 2022 to better match trip length and travel time estimated by the model to the data from CHTS and StreetLight.

Vehicle Availability

BCAG Model includes the feature of vehicle availability as an input to both the trip distribution and mode choice. The vehicle availability model is a disaggregate multinomial logit model which predicts the probability of a household owning 0, 1, 2, or 3, or 4+ vehicles based on the variables in **Table 18**.

Table 18: Variables in Vehicle Availability Model

Category	Variable	Description
Cost Variable	Commute Cost Ratio	Average annual commute cost divided by household income
Accessibility Variables	Intersection Density	Intersections per square mile
	Transit Accessibility	Jobs within 30 minutes via transit
	Employment Density	Log of (jobs per developed acre)
Household Demographic Variables	Household Size	Household size 1, 2, 3, 4+
	Household Income	Less than $35K, $35K – $50K, $50K – $75K, Greater than $75K
	Household Residential Unit Type	Single Family, Multi-Family, Mobile Home

Source: Fehr & Peers, 2024.

The commute cost ratio variable is an estimate of the proportion of a household's income required to own vehicles. It is derived from a county-level estimate of per-mile auto ownership costs, tract-level estimates of commuting VMT derived from the EPA's Smart Location Calculator[8], an annualization factor of 250 working days per year, and the household income. The variable is applied on a per-vehicle basis, so that owning no vehicles incurs no cost, owning two vehicles incurs twice the cost of owning one vehicle, and so on. **Table 19** below provides the coefficients of the auto ownership model.

[7] Martin, W. A., & McGuckin, N. A. (1998). *Travel Estimation Techniques for Urban Planning* (Report 365). Washington, DC: National Academy Press.

[8] https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources

Table 19: Auto Ownership Model Coefficients

	0 Vehicles	1 Vehicle	2 Vehicles	3 Vehicles	4+ Vehicles
Alternative-Specific Constant					
CommuteCostRatio	7.51	3.95	0.00	0.00	0.00
PedOrIntDens	0.009	0	0	-0.004	-0.004
TransitAccessibility (x1000)	0.009	0.010	0	-0.051	-0.112
LogEmpDensity	0.39	0.24	0	0.00	-0.19
RUGroup=RU1	0	0	0	0	0
RUGroup=RU3	1.27	0.53	0	-1.53	-1.53
RUGroup=RU6	0.27	0.27	0	0	0
RUGroup=RU4[1]	1.27	0.53	0	-1.53	-1.53
HH_size=1	-1.16	1.5	0	-3.15	-4.94
HH_size=2	-3.03	-0.42	0	-2.26	-4.19
HH_size=3	-3.37	-0.24	0	-1.34	-3.40
HH_size=4	-4.02	-0.66	0	-1.61	-3.13
HH_size=5+	-3.50	-0.89	0	-1.32	-2.44
HH_inc=IncG1	0	0	0	0	0
HH_inc=IncG2	-1.33	-0.28	0	0.86	0.98
HH_inc=IncG3	-3.87	-0.93	0	1.2	2.35
HH_inc=IncG4	-2.98	-1.55	0	1.55	2.35
HH_inc=IncG5	-4.23	-1.96	0	1.44	2.87

Notes:
1. The coefficients are added for the new land use type College on-campus student housing, and they are the same as the coefficients used for multi-family housing.
Source: Fehr & Peers, 2024.

Note the model uses owning two vehicles as its base, and calculates the relative probability of owning fewer or greater vehicles; thus, the model coefficients describe relative probabilities as in the example below:

$$\ln\left(\frac{Prob(0\ vehicles)}{Prob(2\ vehicles)}\right) = 7.51(CommuteCostRatio) + 0.0093(PedOrIntDensity) + \ \dots$$

The coefficients for this model are generally intuitive in direction and scale.

- Higher commuting cost increases the probability of owning 0 or 1 vehicles and decreases the probability of owning 3 or 4 vehicles, as compared to the baseline of 2 vehicles.

- Higher scores for the three accessibility variables, indicating generally better accessibility by non-auto modes, increase the probability of owning 0 vehicles (and sometimes also 1 vehicle) relative to owning 2; and decrease the probability of owning 3 or 4.
- Household income is the demographic variable which has the largest influence in auto ownership. Generally, as incomes go up, probabilities of owning 0 or 1 vehicles go down, and probabilities of owning 3 or 4 vehicles go up.
- Household size behaves in the expected way, with probability of owning 0 or 1 vehicles going down as household size increases and probability of owning 3 or 4 vehicles going up.
- Multi-family unit types are more likely to own 0 or 1 vehicles, and less likely to own 3 or 4 vehicles, than single family. There weren't enough records in the RUG6 "other" category (RV, mobile home, etc.) to distinguish them from single family, and they were generally more similar to single family than multi-family uses, so they share the same coefficients as single family.

An important consideration for future model development is that car sharing and transportation network companies (i.e., UBER, LYFT, etc.) are changing auto availability dynamics and, potentially, long-term auto ownership. As more data becomes available it may be appropriate to modify the auto ownership model to recognize these changes and focus more on auto availability across multiple sub modes and costs per mile. **Table 20** summarizes the autos owned for both the model and the CHTS.

Table 20: Percent of Autos Owned

Autos Owned	Model	CHTS
0	7%	9%
1	39%	37%
2	40%	34%
3+	14%	20%

Source: Fehr & Peers, 2024.

Mode Choice

With the addition of vehicle availability, person trips, and a multimodal network with simplified transit, the model implemented a full multinomial logit mode choice model that was developed for the San Joaquin Valley MPOs due to the similar rural character and transportation options. A nested logit form might have been preferred for theoretical reasons, given the strong relationships among drive, transit, and active modes. However, no satisfactory nested logit models were estimated, likely because of severe constraints on the amount of transit data available. Multinomial logit models produced generally more sensible results and were used instead. The mode choice model is segmented by trip purpose and vehicle availability, using three vehicle availability categories as described in **Table 21**.

Table 21: Vehicle Availability Segments in Mode Choice Model

Name	Description
0veh	Households which own no vehicles
1veh	Households which have one vehicle but more than one person
Others	Households with either one vehicle and one person, or more than one vehicle

Source: Fehr & Peers, 2024.

Table 22 below lists the modes available in the model.

Table 22: Modes Available in Mode Choice Models

Category	Name	Segments Available	Trip Purposes	Description
Auto	da	1Veh, Other	All	Drive-alone
	s2	All	All	Shared ride, 2 persons
	s3	All	All	Shared ride, 3+ persons
Transit	twb	All	All	Transit, walk-access, bus
	tdb	All	All	Transit, drive-access, bus
	twr	All	All but HBK, HBC	Transit, walk-access, rail
	tdr	All	All but HBK, HBC	Transit, drive-access, rail
	sb	All	HBK only	School bus
Active	walk	All	All	Walk
	bike	All	All	Bike

Source: Fehr & Peers, 2024.

The variables used in each of the modes in the choice model are listed in **Table 23** below. Not all variables are used in all trip purposes models. For the accessibility and built environment variables, the table notes whether the variable is measured at the trip production (P) or trip attraction (A). Note that value of time is a direct consequence of the relationship between in-vehicle time and cost. As such, it is not estimated directly but is instead a consequence of the in-vehicle time (IVT) and cost coefficients. For model implementation purposes, only value of time (VOT) is used in the mode choice utility equation; for clarity, both are reported in the tables below.

Table 23: Variables in Mode Choice Models

Variable	Purposes	Description
(Constants)	All	Alternative-specific constants
IVT	All	In-vehicle time
OVT	All	Out-of-vehicle time (access, transfer, egress, and waiting times)
Cost	All	Total cost, including auto operating cost, parking cost and tolls, and transit fares.
VOT	All	Value of time (conversion between cost variables and time variables)
TransitAccess	HBW, WBO, OBO	Jobs available within 30 minutes via transit, decay-weighted (P)
LogEmpDensity	HBW, HBS, HBO	Log (employment density of block group) (A)
IntDensity	HBK, HBC	Pedestrian-oriented intersection density (A)

Source: Fehr & Peers, 2024.

Home-Based Work

Table 24 lists model coefficients for HBW segments. Drive-alone was used as a reference mode for all trip purposes including the 0-vehicle segment where this mode is not permitted. In this segment, utility calculations were carried out without the drive-alone mode.

Table 24: HBW Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	-0.16	0.53	2.265
	s2	0.6	-0.06	-0.32
	s3	0	-3	-3.3
	twb	2.614	-1.26	-1.899
	tdb	1.361	-1.26	-2.866
	twr	2.614	-1.26	-1.899
	tdr	1.361	-1.26	-2.866
	bike	1	-3	-3.5
	walk	0.974	-3.633	-3.822
IVT	All	-0.03	-0.03	-0.074
OVT	All	-0.06	-0.06	-0.148
OVT/IVT	All	2	2	2
Cost	All	-0.004	-0.003	-0.005
VOT	All	6.5394	7.56	11.34

Table 24: HBW Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
LogEmpDensity	da	0	0	0
	s2	-0.005	-0.005	0
	s3	-0.02	-0.02	0
	twb	0.04	0.04	0.025
	tdb	0.04	0.04	0.025
	twr	0.04	0.04	0.025
	tdr	0.04	0.04	0.025
	bike	0.03	0.03	0
	walk	0.039	0.039	0.039
TransitAccess	da	0	0	0
	s2	0.013	0.013	0.005
	s3	0.013	0.013	0.005
	twb	0.03	0.027	0.013
	tdb	0.03	0.027	0.013
	twr	0.03	0.027	0.013
	tdr	0.03	0.027	0.013
	bike	0.03	0.031	0.015
	walk	0.04	0.031	0.015

Source: Fehr & Peers, 2024.

Home-Based Shop

Table 25 below lists model coefficients for HBS segments. Drive-alone was used as a reference mode for the 1-vehicle and 2-vehicle segments, while walk was used as a reference mode for the 0-vehicle segment.

Table 25: HBS Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	-0.2	-0.1	0
	s2	-0.5	-0.7	-0.9
	s3	-1.5	-1.6	-1.8
	twb	-4.036	-3.901	-1.915
	tdb	-3.249	-3.114	-2.747
	twr	-4.036	-3.901	-1.915
	tdr	-3.249	-3.114	-1.959
	bike	-1	-2	-3
	walk	-2	-2	-2
IVT	All	-0.035	-0.035	-0.03
OVT	All	-0.088025	-0.088025	-0.07545
OVT/IVT	All	2.515	2.515	2.515
Cost	All	-0.004	-0.001	-0.001
VOT	All	6.08	16.62	18
LogEmpDensity	da	0	0	0
	s2	0.506	0.506	0.506
	s3	0.408	0.408	0.408
	twb	0.5	0.5	0.5
	tdb	0.5	0.5	0.5
	twr	0.5	0.5	0.5
	tdr	0.5	0.5	0.5
	bike	0.506	0.506	0.506
	walk	0.5	0.178	0.005

Source: Fehr & Peers, 2024.

Home-Based School (K-12)

Table 26 below lists model coefficients for SCHOOL segments. The reference mode for the 0- and 1-vehicle segments is walk; the reference mode for the 2-vehicle segment is shared ride 3.

Table 26: SCHOOL Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	2	1	-0.5
	s3	2.813	2.884	1.033
	twb	0.614	-5.873	-6.902
	tdb	-7.06	-8.09	-9.119
	twr	0.614	-5.873	-6.902
	tdr	-7.06	-8.09	-9.119
	bike	1.306	1.75	1.01
	walk	5.383	5.076	4.206
	sb	1.306	1.75	1.01
IVT	All	-0.025	-0.025	-0.025
OVT	All	-0.05	-0.05	-0.05
OVT/IVT	All	2	2	2
Cost	All	-0.005	-0.003	-0.002
VOT	All	3	6	9
IntDensity	da	0	0	0
	s2	0.006	0.006	0.006
	s3	0.008	0.008	0.008
	twb	0.008	0.008	0.008
	tdb	0	0	0
	twr	0.008	0.008	0.008
	tdr	0	0	0
	bike	0.008	0.008	0.008
	walk	0.004	0.004	0.004
	sb	0	0	0

Source: Fehr & Peers, 2024.

Home-Based University

Table 27 below lists model coefficients for UNIV segments. Because of the very small number of trips in the household survey data, all vehicle ownership segments were pooled for model estimation purposes, with distinctions between segments left for adjustment during model calibration. Drive-alone was used as a reference mode. In the 0-vehicle segment, utility calculations were carried out without the drive-alone mode.

Table 27: UNIV Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	-2.5	-2.4	-2.3
	s3	-4	-5	-5.5
	twb	-1.44	-1.9	-2.36
	tdb	-5.919	-6.379	-6.839
	twr	-1.44	-1.9	-2.36
	tdr	-5.919	-6.379	-6.839
	bike	-6	-7	-8
	walk	-8.494	-7.299	-8.494
IVT	All	-0.025	-0.025	-0.025
OVT	All	-0.05	-0.05	-0.05
OVT/IVT	All	2	2	2
Cost	All	-0.005	-0.003	-0.002
VOT	All	3	6	9
IntDensity	da	0	0	0
	s2	0.004	0.004	0
	s3	-0.019	-0.019	0
	twb	0.004	0.004	0
	tdb	0	0	0
	twr	0	0	0
	tdr	0	0	0
	bike	0.005	0.005	0.005
	walk	0.005	0.005	0.005

Source: Fehr & Peers, 2024.

Home-Based Other

Table 28 below lists model coefficients for HBO segments. Drive-alone was used as a reference mode for the 2-vehicle segment, while walk was used as a reference mode for the 0- and 1-vehicle segments.

Table 28: HBO Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	-0.2	-0.1	0
	s2	-0.5	-0.7	-0.9
	s3	-1.5	-1.6	-1.8
	twb	-4.036	-3.901	-1.915
	tdb	-3.249	-3.114	-2.747
	twr	-4.036	-3.901	-1.915
	tdr	-3.249	-3.114	-1.959
	bike	-1	-2	-3
	walk	-2	-2	-2
IVT	All	-0.035	-0.035	-0.03
OVT	All	-0.088025	-0.088025	-0.07545
OVT/IVT	All	2.515	2.515	2.515
Cost	All	-0.004	-0.001	-0.001
VOT	All	6.08	16.62	18
LogEmpDensity	da	0	0	0
	s2	0.506	0.506	0.506
	s3	0.408	0.408	0.408
	twb	0.5	0.5	0.5
	tdb	0.5	0.5	0.5
	twr	0.5	0.5	0.5
	tdr	0.5	0.5	0.5
	bike	0.506	0.506	0.506
	walk	0.5	0.178	0.005

Source: Fehr & Peers, 2024.

Work-Based Other

Table 29 below lists model coefficients for WO segments. Walk was used as a reference mode for the 0- and 1-vehicle segments; drive-alone was used as a reference mode for the 2-vehicle segment.

Table 29: WO Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	-1.53	-1.682	-1.915
	s3	-1.77	-1.798	-1.939
	twb	-4.036	-3.901	-1.915
	tdb	-3.249	-3.114	-2.747
	twr	-4.036	-3.901	-1.915
	tdr	-3.249	-3.114	-1.959
	bike	-4.704	-5.343	-7.99
	walk	-2.62	-2.553	-2.665
IVT	All	-0.035	-0.035	-0.03
OVT	All	-0.088025	-0.088025	-0.07545
OVT/IVT	All	2.515	2.515	2.515
Cost	All	-0.004	-0.001	-0.001
VOT	All	6.08	16.62	18
TransitAccess	da	0	0	0
	s2	0	0	0
	s3	0	0	0
	twb	0.023	0.023	0.023
	tdb	0.023	0.023	0.023
	twr	0.023	0.023	0.023
	tdr	0.023	0.023	0.023
	bike	0.03	0.03	0.03
	walk	0.04	0.04	0.04

Source: Fehr & Peers, 2024.

Other-Based Other

Table 30 below lists model coefficients for OO segments. Walk was used as a reference mode for the 0- and 1-vehicle segments; drive-alone was used as a reference mode for the 2-vehicle segment.

Table 30: OO Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	2.351	0.838	0.211
	s3	2.245	0.507	0.135
	twb	2.614	-1.26	-1.899
	tdb	1.361	-1.26	-2.866
	twr	2.614	-1.26	-1.899
	tdr	1.361	-1.26	-2.866
	bike	0.974	-3.633	-3.822
	walk	4.293	0.911	-0.258
IVT	All	-0.03	-0.03	-0.074
OVT	All	-0.06	-0.06	-0.148
OVT/IVT	All	2	2	2
Cost	All	-0.004	-0.003	-0.005
VOT	All	5.19	6	9
TransitAccess	da	0	0	0
	s2	-0.007	-0.007	0
	s3	-0.01	-0.01	0
	twb	0.04	0.04	0.025
	tdb	0.04	0.04	0.025
	twr	0.04	0.04	0.025
	tdr	0.04	0.04	0.025
	bike	0.03	0.03	0
	walk	0.039	0.039	0.039

Source: Fehr & Peers, 2024.

Table 31 summarizes the aggregated mode choice for both the model and the CHTS. Note that while the model produces results for each individual mode by purpose, due to sample size in the CHTS the aggregated mode shares are used for validation. Prior to using the detailed mode choice by purpose and mode, a sub-area validation and potential calibration should be undertaken.

Table 31: Mode Choice Results

Mode	Model	CHTS
Drive-alone	47.4%	43%
Shared Ride	43.6%	46%
Transit	1.9%	3%
Walk/Bike/Other	7.1%	8%

Note: Other includes school bus, taxi, and other specialized modes accounted for in the CHTS.
Source: Fehr & Peers, 2024.

Trip Assignment

The trip assignment process determines the route each vehicle trip takes from a particular origin to a particular destination. It uses an iterative, capacity-restrained assignment routine to determine a travel path that minimizes travel time, while considering congestion delays caused by the other simulated trips in the model. The model added new capabilities to account for the number of passengers in the car for passenger trips, the type of truck being used (small, medium, and large) for commercial trips, and the potential for roadway pricing on a roadway segment on a per mile basis or spot location for a single charge.

The general assignment process includes the following steps.

- Assign all trips to the links along their selected paths
- After all assignments, examine the volume on each link and adjust its impedance based on the volume-to-capacity ratio
- Repeat the assignment process for a set number of iterations or until specified criteria related to minimizing travel delays are satisfied

Calibration of the roadway network included modification of the centroid connectors to more accurately represent the location that traffic accesses local roads; adjustment of speeds from posted speed limits to reflect the attractiveness of the route and the prevailing speed of traffic; and adjustment of capacities to reflect the attractiveness of the route.

Time Periods

The model estimates travel for the average weekday (Monday through Friday). The daily roadway volumes are aggregated from the AM and PM peak period, and Mid-day and Evening off-peak period assignments. Descriptions of each assignment time period are presented in **Table 32**. The specific time periods represented in the model were developed by reviewing the distribution of existing traffic counts across a 24-hour period as well as reviewing the time period distributions of travel models in neighboring jurisdictions (i.e., NCTC, SACOG, TRPA).

Table 32: Time Periods

Description	Duration	Time
AM Peak Period	3 Hours	6:00 – 8:59 AM
Mid-day Period	7 Hours	9:00 AM – 3:59 PM
PM Peak Period	3 Hours	4:00 – 6:59 PM
Off-Peak Period	11 Hours	7:00 PM – 5:59 AM
AM Peak Hour	1 Hour	7:00 – 7:59 AM
PM Peak Hour	1 Hour	5:00 – 5:59 PM

Source: Fehr & Peers, 2024.

Turn Penalties

Turn penalties are used to prohibit or add delay to certain turning movements. The BCAG model prohibits traffic from making turns across impassable medians. In addition, the model may prohibit U-turns at some locations to avoid counterintuitive traffic routing. Turn penalties may be in effect during the entire day, during one or all peak periods, or only at the peak hour level. Currently the turn penalties apply to all vehicles and there are no specific truck only turn penalties or prohibitions.

Vehicle Miles of Travel

A major focus of recent transportation related legislation in California focuses on VMT. In addition to Air Quality Conformity determinations, SB 375 and subsequent legislation such as SB 743 have highlighted the need to have a reliable method for forecasting VMT for regional planning. The traditional reasonableness check for VMT is to compare the regional model to HPMS for VMT on the roadways with the model area. **Table 33** below shows that the VMT for the model is about 13.6% lower than Year 2019 HPMS, 5.5% higher than Year 2021 HPMS, and 9% higher than Year 2022 HPMS, which exceeds the 3% suggested error.

However, the HPMS estimates do not match traffic count or StreetLight traffic volume estimate trends between 2019 and 2022. While HPMS VMT estimates appear to capture changes due to the COVID 19 pandemic effects in terms of the decrease between 2019 and 2021. No rebound effect is shown for 2022. The traffic counts and StreetLight estimates both show the expected rebound effect, which also includes the active re-development of the Town of Paradise after the Camp Fire. Hence, the model-wide VMT estimate for Year 2022 is considered reasonable.

Table 33: Model-wide VMT

Year	HPMS	Model	% Deviation	% Through trip VMT
2019	5,349,710	4,620,750	-13.6	1.9%
2021	4,379,640		5.5%	
2022	4,239,790		9.0%	

Note:
HPMS estimates from 2019, 2021 and 2022 for all roadways in Butte County
Source: Fehr & Peers, 2024.

Transit Forecasting

Although the simplified representation of transit in terms of access and headway is validated at the regional mode share level, the mode choice and distribution processes allow for evaluation of mode share at the zone-to-zone and individual zone levels. Interregional transit must be done off-model. The regional mode share for transit from the travel model and CHTS are shown in **Table 31.**

4 Model Validation

Model validation is the term used to describe model performance in terms of how closely the model's output matches existing travel data in the base year. The extent to which model outputs match existing travel data validates the model algorithms and inputs.

Traditionally, most model validation guidelines have focused on the performance of the trip assignment function in accurately assigning trips to the roadway network. This method is called static validation, and it remains the most common means of measuring model's ability to replicate base year observed conditions.

Models, however, are seldom used for static applications. By far the most common use of models is to forecast how a change in inputs would result in a change in traffic conditions. Therefore, another test of a model's accuracy focuses on the model's ability to predict realistic differences in outputs as inputs are changed. This method is referred to as dynamic validation. This section describes the highest-level validation checks that have been performed for the model.

Static Validation

The 2024 *California Regional Transportation Plan Guidelines* [9], contains the following specific static validation criteria and thresholds.

- *At least 75 percent of the roadway links for which counts are available should be within the maximum desirable deviation*, which ranges from approximately 15 to 60 percent depending on total volume (the larger the volume, the less deviation is permitted).
- *A correlation coefficient of at least 0.88* – The correlation coefficient estimates the overall level of accuracy between observed traffic counts and the estimated traffic volumes from the model. These coefficient ranges from 0 to 1.0, where 1.0 indicates that the model perfectly fits the data.
- *The percent root mean squared error (%RMSE) below 40%* – The %RMSE is the square root of the model volume minus the actual count squared, divided by the number of counts. In other words, it is the average of all the link-by-link percent differences, and it is an indicator of how far the model volumes differ from the counts, on a link-by-link average, expressed as a percent. It is a measure similar to standard deviation in that it assesses the accuracy of the entire model.

In addition to these criteria, the model-wide volume-to-count ratio was checked against a desired maximum threshold of no more than a 10 percent deviation. The static validation results for the model are show in **Table 34** and reveal that the model passed all thresholds for daily and closed to the other threshold for AM and PM peak hour. It is important to pre-validate the model with local counts if it is

[9] *California Regional Transportation Plan Guidelines.* (2024). Sacramento, CA: California Transportation Commission.

used for a focus-area project. Further refinement of the access point of centroid connectors can help with focus-area validation.

Table 34: Results of Model Validation

Validation Item	Criterion of Acceptance	Daily	AMPH	PMPH
Model-wide Volume-to-Count Ratio	Within ± 10%	0.99	0.97	1.00
Percent of Links Within Deviation Allowance	At Least 75%	76%	82%	83%
Correlation Coefficient	At Least 88%	96%	90%	93%
RMSE	40% or Less	37%	47%	41%

Source: Fehr & Peers, 2024.

Dynamic Validation and CARB Model Sensitivity Tests

The tests below were conducted to evaluate the functionality of the model directly related to the scenarios being evaluated as part of the 2024 RTP/SCS, and to provide both BCAG and CARB information for determining the capabilities and sensitivity to the different features of the model. The results of the dynamic validation do not fully match with static validation. Static validation was slightly adjusted after the dynamic validation was done. Based on our conversation with CARB on February 3rd, 2023, the model dynamic sensitivity test for active transportation and transit enhancement was not repeated for the 2024 RTP/SCS, as similar testing was performed for the 2020 RTP/SCS. Since no major structural changes were made to the BCAG model between the 2020 and 2024 RTP/SCS, the dynamic test results documented for 2020 RTP/SCS are expected to yield similar results as previously documented.

Beyond what was documented for the 2020 RTP/SCS, and as recommended by CARB, short-term induced vehicle travel, and additional land use sensitivity tests were conducted to evaluate how the model responds to potential strategies for the 2024 RTP/SCS.

Induced Vehicle Travel

The balance between traveler convenience and increased auto dependency is at the core of many legislative initiatives in California. MPOs expected to manage congestion while also reducing VMT. As such, induced vehicle travel effects are an essential consideration in forecasting VMT especially when future conditions included through expansion of roadway capacity. To evaluate the model sensitivity to induced vehicle travel, short-term effects of increased roadway capacity listed below were evaluated by comparing different combinations of roadway network and socioeconomics.

Short-term responses

1. New vehicle trips that would otherwise would not be made

2. Longer vehicle trips to more distant destinations
3. Shifts from other modes to driving
4. Shifts from one driving route to another

Long-term induced vehicle travel responses listed below are not directly included in the model. Instead, the model's inputs would have to be modified to capture these changes.

5. Changes in land use development patterns (these are often more dispersed, low-density patterns that are auto dependent)
6. Changes in overall growth

Short-Term Induced Vehicle Travel

Short-term induced travel is caused by the immediate change in speeds and travel when a new roadway capacity expansion project is open to traffic (i.e. a Build compared to a No Build scenario). To reflect the short-term induced vehicle travel, additional lane miles were added to the base year roadway network to assess the effect on VMT. Based on CARB's research on induced travel [10] , two tests were developed to evaluate how the model responds to short-term induced vehicle travel resulting from capacity changes on state highway facilities.

- *Test 1* added one lane in each direction on SR 70 between Ophir Road and SR 149, resulting in an 18-lane mile increase.
- *Test 2* added one lane in each direction on SR 99 between SR 149 and Garner Ln, resulting in a 51-lane mile increase.

Full model runs are conducted for both tests, which may overstate the short-term effects of these capacity increases because work and school locations would not realistically change.

Based on the 2024 RTP/SCS 2022 base year run assignment results, SR 70 is operating at near free-flow conditions, with a volume-to-capacity (VC) ratio between 0.3 and 0.7. In contrast, SR 99 is experiencing congestion, with a VC ratio ranging from 0.3 to 1.2, and about 37% of the segment operating above 0.8. Thus, these two state route segments were selected for the tests to understand how the starting congestion context influences the outputs. As shown in **Table 35**, the VMT changes for both tests are in the expected direction, and the differences in short-term elasticity align with the model test setup.

For Test 1, adding new lane miles on SR 70 has a limited impact on total VMT, which is consistent with the low levels of congestion on SR 70 and no travel time benefit of the network modification. However, for Test 2, where additional lane miles were added to the more congested SR 99, the total VMT change is significantly higher than in Test 1. This outcome aligns with the expected response to increased roadway capacity on congested facilities. Therefore, the model output demonstrates an appropriate sensitivity to

[10] https://ww2.arb.ca.gov/sites/default/files/2020-06/Impact_of_Highway_Capacity_and_Induced_Travel_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf

short-term induced travel in terms of the direction of change. However, the ARB research on short-term induced effect size suggests a reasonable range of 0.1 to 0.6. The lower values reported for the BCAG model may be reasonable given that existing congestion in the county is not sufficient to suppress vehicle trip making given that the model's calibrated and validated rates are similar to ITE trip rates from suburban areas where trip making occurs at full demand levels with little to no constraints due to congestion.

Table 35: Short-Term Induced Vehicle Travel Elasticity Check

Scenarios	Base Year	Test 1	Change	Test 2	Change
Lane Miles	392	410	-4.82%	443	-13.05%
Total VMT	2,804,315	2,804,683	-0.01%	2,812,936	-0.31%
Model VMT Change	-	368		8,621	
Short Term Elasticity	-	0.003		0.024	

Note:

1. The total lane miles and total VMT calculations include only the Federal Highway Administration (FHWA) functional classification (FC) 1-3 roadway facilities in Butte County. This approach is consistent with the discussion on the impact of highway capacity and induced travel in estimating short-term induced VMT. https://dot.ca.gov/programs/research-innovation-system-information/office-of-highway-system-information-performance/functional-classification

Source: Fehr & Peers, 2024.

Long-Term Induced Vehicle Travel

Long-term induced vehicle travel effects consider the influence on land use and growth patterns over time. Travel models are typically used to compare a Build and No Build condition and combine the influence of land use, demographics, socioeconomic conditions, and travel. As such, they produce forecasts of short-term induced vehicle travel effects. For long-term induced vehicle travel effects, the model land use and trip generation rates would need to be changed for each alternative. Alternatively, an off-model elasticity method such as that applied through California induced travel calculator[11] developed by National Center for Sustainable Transportation Center can be used.

Auto Operating Cost

The recommended CARB auto operating cost (AOC) methodology changed from including only petroleum-based vehicles to all energy sources. To test model sensitivity to the changes, the auto operating cost is increased by 20% from what was recommended based on the updated method. The published literature presents the demand for fuel or the VMT and has only the impact of gas price not total auto operating cost as used in the model to determine auto ownership, distribution, travel mode, and route choice. The literature reports a short-term elasticity of VMT change relative to fuel price of -0.24 for low-income groups to -0.40 for high income groups.

[11] California Induced Travel Calculator: https://travelcalculator.ncst.ucdavis.edu/

Table 36 below shows the results for the base year with a similar VMT elasticity in both magnitude and direction. The negative on the elasticity indicates the VMT changes in the opposite direction than the auto operating cost. Although the magnitude of change is less than the expected range for fuel price, the recommended CARB parameter of auto operating cost accounts for more than fuel price and the past literature based on empirical data does not account for the non-petroleum vehicles currently included in the auto operating cost. As the fuel price decreases due to more efficient vehicles, the fixed costs become a larger percentage of the auto operating cost. Since the model is not overly sensitive to auto operating cost but does show reasonable sensitivity, the model is appropriate for RTP/SCS scenarios that do not include change of fleet or fuel sources. If the scenario being evaluated changes the auto operating cost or fuel cost as a scenario specific policy, it is recommended that additional calibration be considered. As noted in the CARB technical document, these results highlight the importance of considering equity impacts in analyzing the effects of changes in gas prices (and gas taxes).

Table 36: Auto Operating Cost Elasticity Check

2022	Updated	Test	Change
AOC	21.38	25.66	20.00%
Total VMT	4,825,405	4,821,531	-0.08%
Model Elasticity	-0.004		
Literature Elasticity [1]	-0.24 to -0.40		

Note:
1. The CARB research for short-term elasticity only accounts for the fuel cost and excludes the fixed and maintenance costs.

Source: Fehr & Peers, 2024.

Land Use Tests

The BCAG Model has been developed to be used as a tool to evaluate land use scenarios in planning efforts such as EIRs, City General Plans, and the Regional Transportation Plan. The specific dynamic validation tests completed for this model update are listed below.

- Add 10, 100, and 1000 dwelling units to a TAZ in Eastern Chico
- Add 10, and 100 thousand square feet of retail to a TAZ in City of Oroville
- Shift growth out of Town of Paradise to Eastern Chico with 500 single family dwelling units
- Adjust income levels by increasing high income households and reducing low-income households with total households remaining the same for TAZs in City of Chico, Paradise, Oroville, Biggs, and Gridley
- Change land use ratio by adding 500 multi family dwelling units and removing 500 single family dwelling units in City of Oroville

The first two tests are generic model dynamic tests designed to ensure that the model consistently produces accurate trip generation estimates for different land use inputs. The key model in these dynamic validation tests is the number of daily vehicle trips (VT) generated. These tests are intended to verify that the model output changes in the correct direction and magnitude. The dynamic validation results for the land use changes, summarized in **Table 37,** indicate that the model responds appropriately to variations in both residential and non-residential land uses. For example, when altering residential uses, the overall vehicle trip generation remains stable across the entire range, yielding reasonable results (i.e., 4.6 to 5.0 vehicle trips per household). Additionally, the change in trip generation at the TAZ level aligns with expectations, with increase or decrease corresponding to changes in the number of households. The magnitude of vehicle trip generation at the TAZ level is also reasonable, considering the socioeconomic characteristics of the test area located in Chico.

Table 37: Land Use Sensitivity Check

Land Use Change	Unit Change	VT Change	VT Change/Unit Change
Residential (Dus)	+10	46.29	4.63
	+100	495.50	4.96
	+1000	4987.53	4.99
	+10	263.83	26.38
	+100	2601.84	26.02

Source: Fehr & Peers, 2024.

The latter three land use dynamic tests were requested by CARB to further evaluate the model's sensitivity to different types of land use changes and to better understand how the location of these land uses affects the model results.

The dynamic test results for land use shifts are summarized in **Table 38**. In this scenario, 500 single-family dwelling units were relocated from the Town of Paradise to the City of Chico. The results indicate a decrease in auto trips and an increase in non-auto trips in the mode split outputs, along with a reduction in total VMT. These changes in the model outputs align with expectations, reflecting the impact of relocating household developments to a more urbanized area like the City of Chico.

Table 38: Land Use Allocation

Trips/VMT	Base Year	Land Use Allocation	Change	Change %
Person Trips - Drive Alone	332,946	332,616	-330	-0.10%
Person Trips - Shared Ride 2	228,781	228,852	71	0.03%
Person Trips - Shared Rid 3+	179,348	179,376	28	0.02%
Person Trips - Transit/Walk/Bike/Other	84,521	85,308	787	0.93%
Person Trips – Total	825,596	826,152	+556	0.07%
Passenger Vehicle Trips	551,168	550,840	-328	-0.06%
Total VMT	4,897,545	4,895,916	-1,629	-0.03%

Source: Fehr & Peers, 2024.

The dynamic test results for income level adjustments are summarized in **Table 39**. When households were shifted from a lower income group to a higher income group, the total number of passenger vehicle trips increased, but total VMT decreased. Higher-income households tend to generate more vehicle trips but travel shorter distances, as they often have the option to live closer to their desired destinations. The model results demonstrate appropriate sensitivity to these income level adjustments.

Table 39: Income Adjustments

Trips/VMT	Base Year	Income Adjustments	Change	Change %
Person Trips - Drive Alone	332,946	333,317	371	0.11%
Person Trips - Shared Ride 2	228,781	228,891	110	0.05%
Person Trips - Shared Rid 3+	179,348	179,441	93	0.05%
Person Trips - Transit/Walk/Bike/Other	84,521	84,510	-11	-0.01%
Person Trips – Total	825,596	826,159	+563	0.07%
Passenger Vehicle Trips	551,168	551,622	454	0.08%
Total VMT	4,897,545	4,896,748	-797	-0.02%

Source: Fehr & Peers, 2024.

The final land use dynamic test involves adjusting the residential land use ratio by shifting single-family dwelling units to multi-family dwelling units. The model results are summarized in **Table 41.** As discussed in the trip generation section, the model's trip generation considers various factors such as land use type, household size, household income level, auto ownership, and more. Rather than relying on a single trip generation rate, the model accounts for the complex nature of socioeconomic data.

With the adjustment in the residential land use ratio, there is a reduction in the total number of person trips and passenger vehicle trips, which is similarly reflected in the total VMT. Since multi-family households have a lower trip generation rate compared to single-family households, the decrease in person trips, vehicle trips, and VMT aligns with the land use ratio adjustments. This demonstrates the model's sensitivity to changes in residential land use ratios.

It's important to note that when applying the model to residential land use projects, additional adjustments should be made for household size, income level, and other relevant inputs.

Table 40: Residential Land Use Ratio Adjustments

Trips/VMT	Base Year	Ratio Adjustments	Change	Change %
Person Trips - Drive Alone	399,588	398,714	-873	-0.22%
Person Trips - Shared Ride 2	246,470	246,044	-425	-0.17%
Person Trips - Shared Rid 3+	108,753	108,631	-122	-0.11%
Person Trips - Transit/Walk/Bike/Other	71,236	71,166	-70	-0.10%
Person Trips - Total	826,046	824,556	-1,490	-0.18%
Passenger Vehicle Trips	590,960	589,848	-1,111	-0.20%
Total VMT	4,745,942	4,737,101	-8,841	-0.19%

Source: Fehr & Peers, 2024.

5 Future Year Model

This section describes the future year model data that were developed, with the following section combining the input data into scenarios for the 2024 RTP/SCS. The inputs that were developed for the future year model include the land use, transportation system, and interregional travel.

Future Land Use

Once the base year model calibration and validation was complete, Fehr & Peers received TAZ growth projections provided by BCAG staff and developed one future year (2045) and one interim (2035) model scenario. **Table 41** reports the land use totals for the base year, interim year, and future year, along with the growth projections.

Table 41: Model Land Use Totals by Scenario Year

Land Use Type	Units	2022	2035	2045
Population	People	197,020	236,433	243,499
Single Family Residential	DU	49,798	58,911	60,522
Multi-Family Residential	DU	25,305	32,441	33,822
Mobile Home Residential	DU	9,055	9,811	9,844
Office	KSF	6,593	8,630	8,677
Medical Office	KSF	2,029	2,558	2,558
Hospitals	KSF	951	1,142	1,148
Industrial	KSF	12,903	15,729	15,729
Public/Quasi-Public	KSF	2,333	2,874	2,939
Park	Acres	491	526	526
Neighborhood-Serving Retail	KSF	11,060	11,764	11,761
Regional-Serving Retail	KSF	884	965	965
Hotels	Rooms	2,270	2,800	2,815
K-12 School	Students	29,040	31,031	31,195
University	Students	12,869	17,892	18,886
Community College	KSF	12,185	17,416	17,508
Casino (CASINO_SLT)	Slots	1,450	1,950	1,974
On Campus Student Housing	Dwelling Units	606	1,098	1,098

Source: BCAG, 2024 RTP/SCS Land Use Forecast.

Future Transportation System

The master network contains the planned and programmed transportation improvements for roadway and bike/pedestrian facilities with attributes related to the number of lanes, facility type, and type of travel allowed to use the facility along with scenario year details. The TAZ file contains the future transit accessibility and headway representing the simplified transit approach described previously. The list of planned and programmed projects can be found in **Appendix D**. It should be noted that this is not a complete listing of projects included in the 2024 RTP/SCS, rather, only projects which include changes to roadway capacity, effect the volume of the roadways, relate to bike/pedestrian facilities, or transit system characteristics.

Future Interregional Travel

For the future year, the production and attraction ratio for all purposes were within the 10% guideline for 2045, and minor imbalance was observed for home-based work trips for 2035 (12% difference between production and attraction). Compared to the base year, the future year job-housing balance remains nearly the same, but the distribution of employment types is significantly different. With the continued increase in online shopping, the growth in retail land use is relatively smaller than in other non-residential land use types, reflecting changes in the interregional trip percentages used for the future scenarios. The adjusted interregional trip percentages remain consistent across the future scenarios.

6 Alternatives Analysis

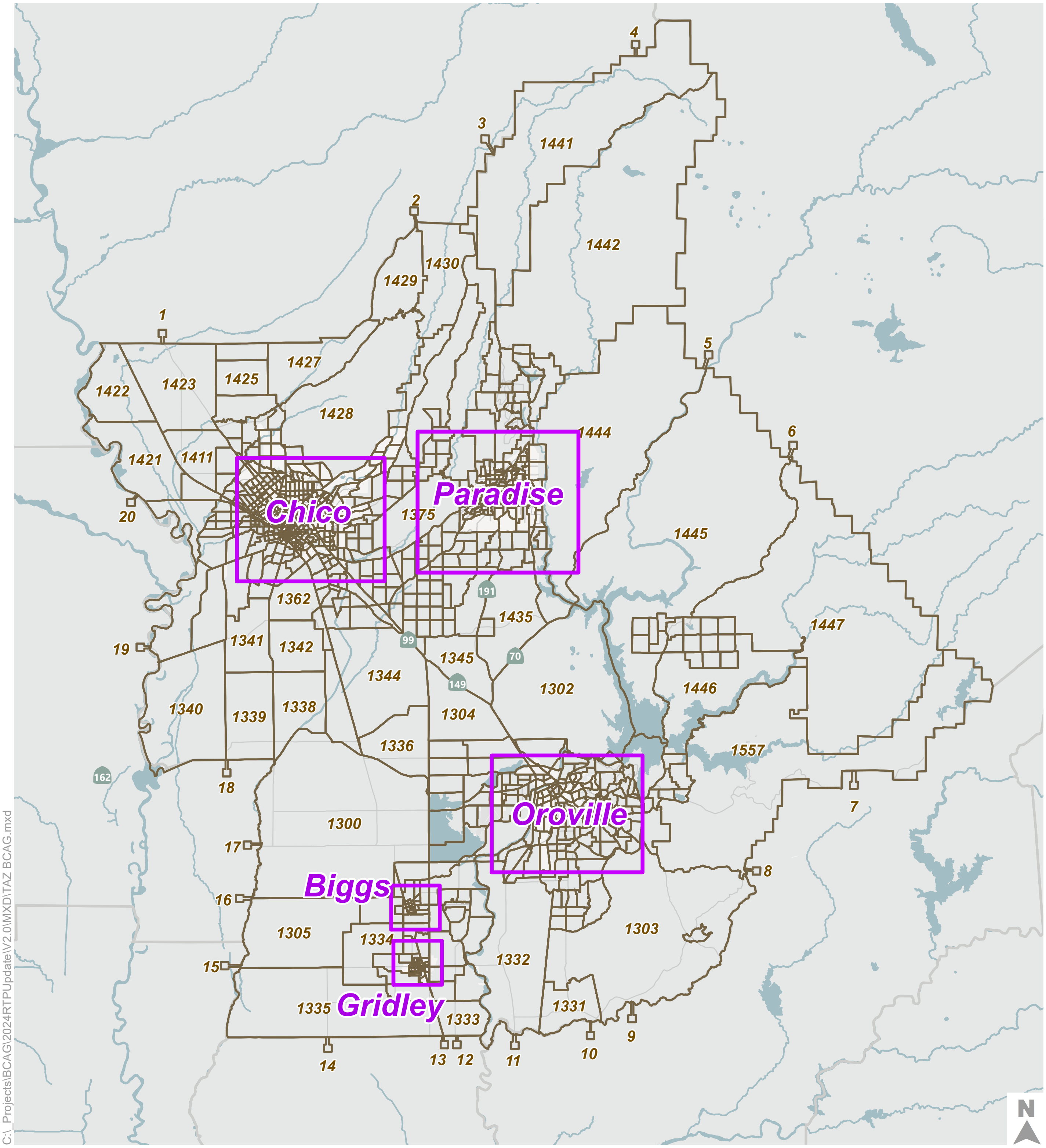
To develop the preferred scenario for the 2024 RTP/SCS, four different scenarios were evaluated for Year 2035. A summary of the roadway projects modeled in scenario 2 and 3, along with the corresponding model results for the four scenarios, can be found in **Appendix E**. Scenario 1 is consistent with 2020 RTP/SCS 2035 preferred scenario and the details can be found in the 2020 RTP/SCS. Scenario 4 is the selected preferred scenario for 2024 RTP/SCS and the details are documented in Chapter 5. The technical methodology employed in developing the land use allocation model, which was used to create the land use inputs for each alternative, is documented in the *Butte County Association of Governments Technical Methodology for Preparing 2024 RTP/SCS Land Use Allocation* (BCAG, 2024). Four land use scenarios were developed for Year 2035, and the land use details are summarized in **Table 42.**

Table 42: Model Land Use for 2035 Alternatives

Land Use Type	Units	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)
Population	People	251,863	236,433	236,433	236,433
Single Family Residential	DU	64,197	60,262	59,293	58,911
Multi-Family Residential	DU	27,924	30,724	32,055	32,441
Mobile Home Residential	DU	11,419	10,140	9,811	9,811
Office	KSF	7,748	7,901	8,559	8,630
Medical Office	KSF	2,427	2,471	2,506	2,558
Hospitals	KSF	1,272	1,142	1,142	1,142
Industrial	KSF	13,631	15,628	15,729	15,729
Public/Quasi-Public	KSF	2,598	2,804	2,804	2,874
Park	Acres	540	555	555	526
Neighborhood-Serving Retail	KSF	13,012	13,268	12,177	11,764
Regional-Serving Retail	KSF	934	1,119	1,052	965
Hotels	Rooms	2,450	2,800	2,835	2,800
K-12 School	Students	34,484	31,031	31,031	31,031
University	Students	18,710	15,463	15,463	17,892
Community College	KSF	14,686	14,641	14,641	17,416
Casino (CASINO_SLT)	Slots	2,257	1,950	1,950	1,950
On Campus Student Housing	Dwelling Units	0	1,098	1,098	1,098

Source: BCAG, 2024 RTP/SCS Land Use Forecast.

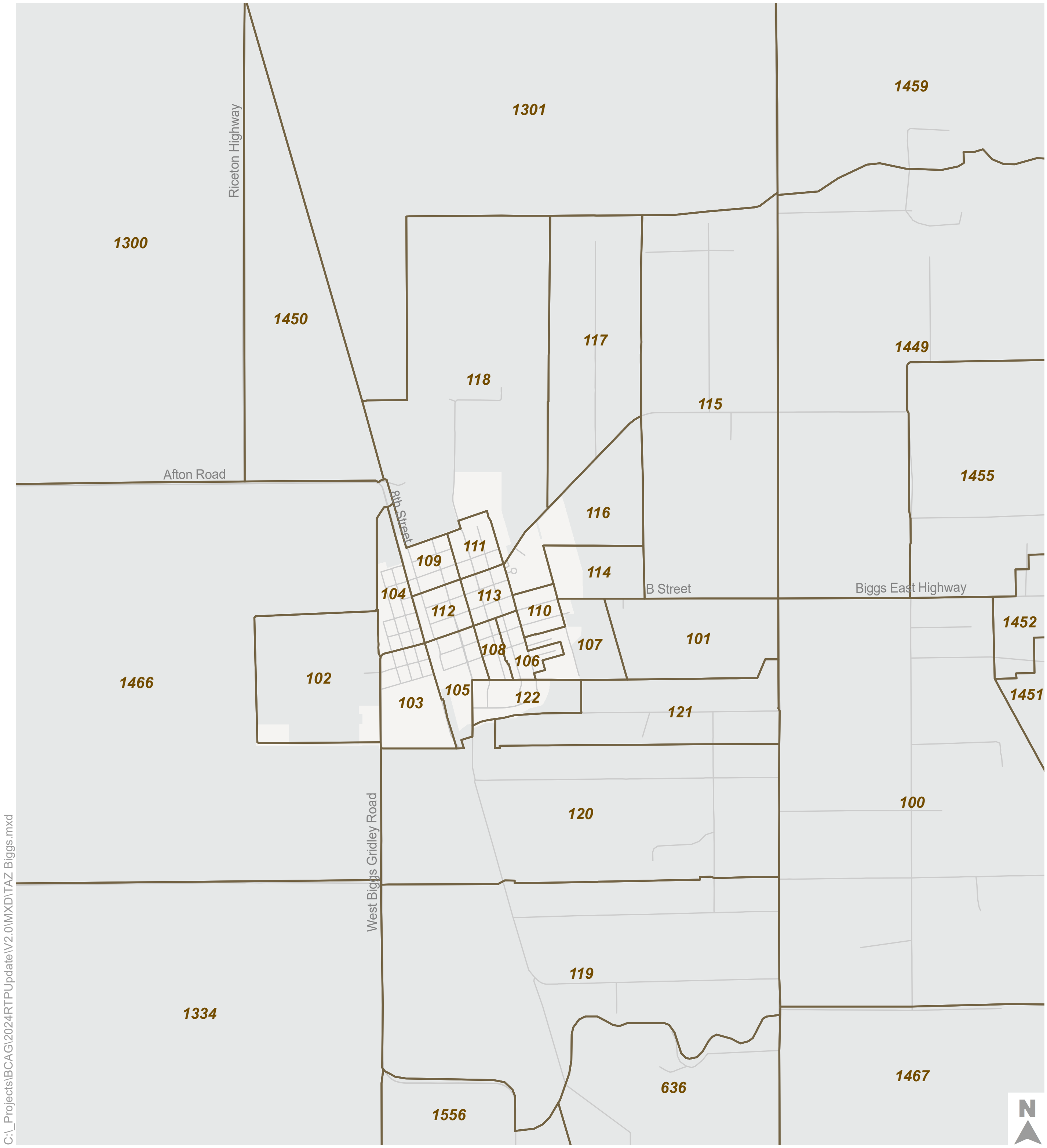
Appendix A:
TAZ Maps



Traffic Analysis Zone Boundaries

City Limits

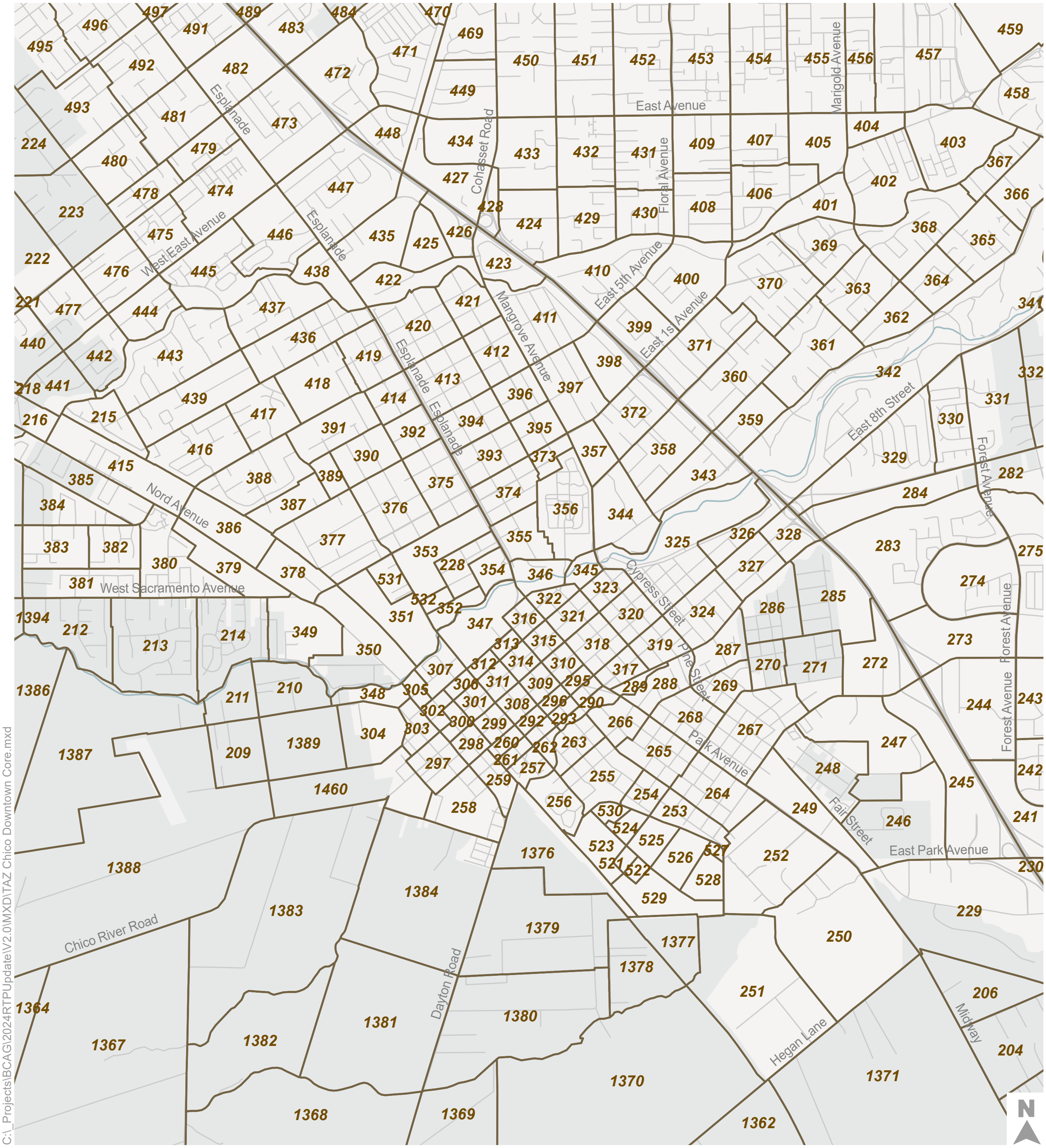
BCAG Model V2.0 - Traffic Analysis Zone Boundaries



Traffic Analysis Zone Boundaries

City Limits

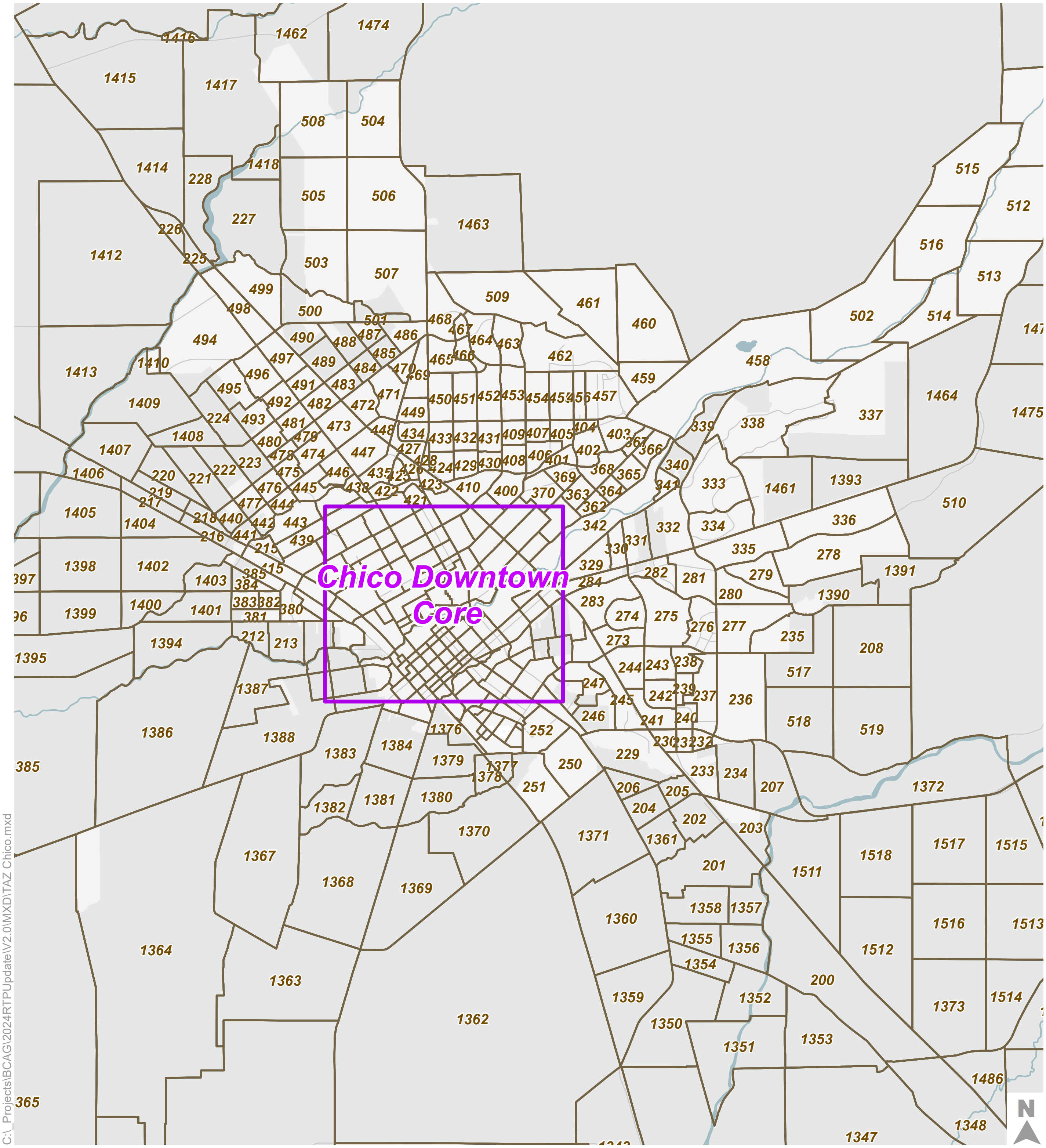
BCAG Model V2.0 - Biggs TAZ Boundaries



Traffic Analysis Zone Boundaries

City Limits

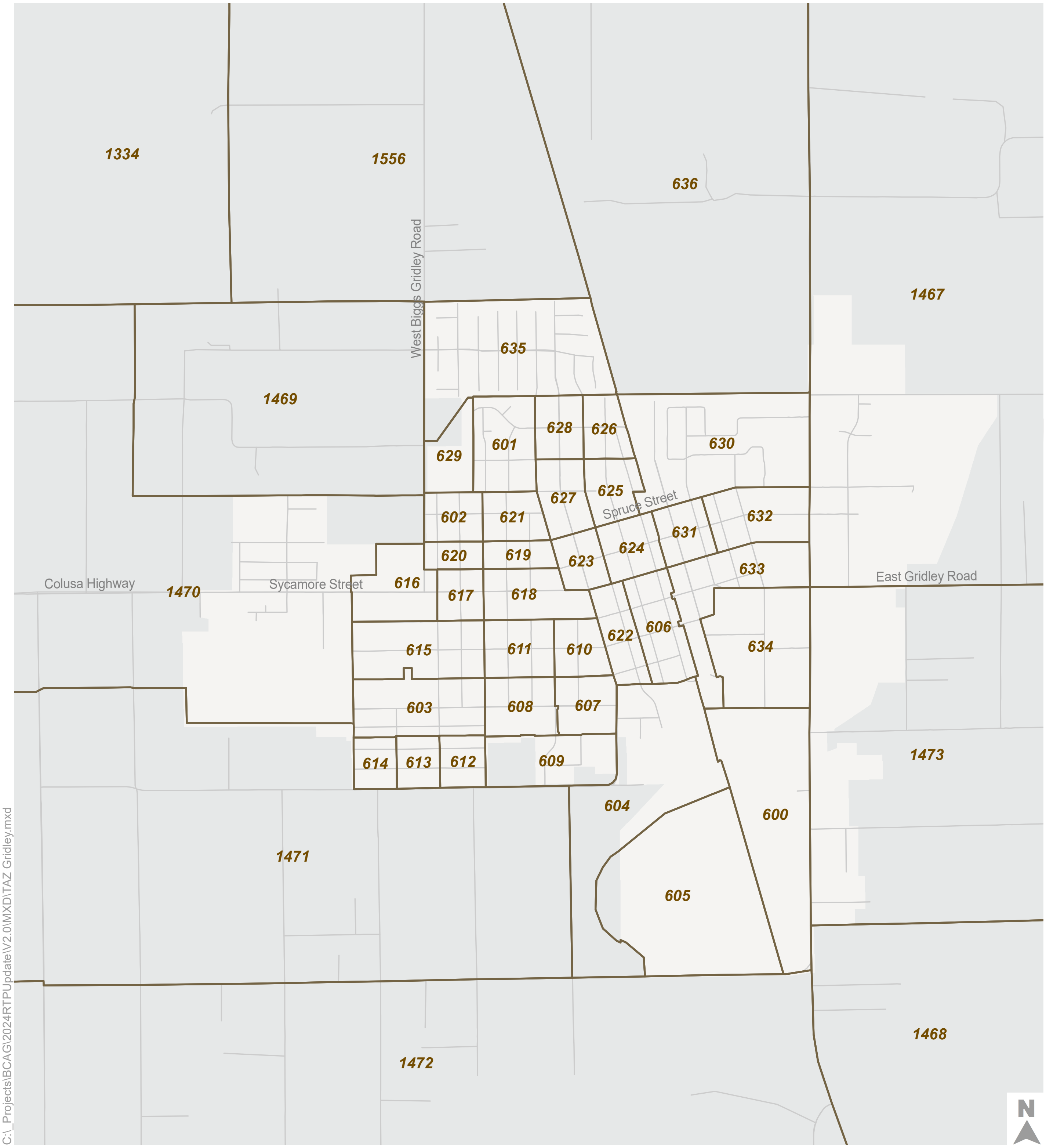
BCAG Model V2.0 - Chico Downtown Core TAZ Boundaries



Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Chico TAZ Boundaries



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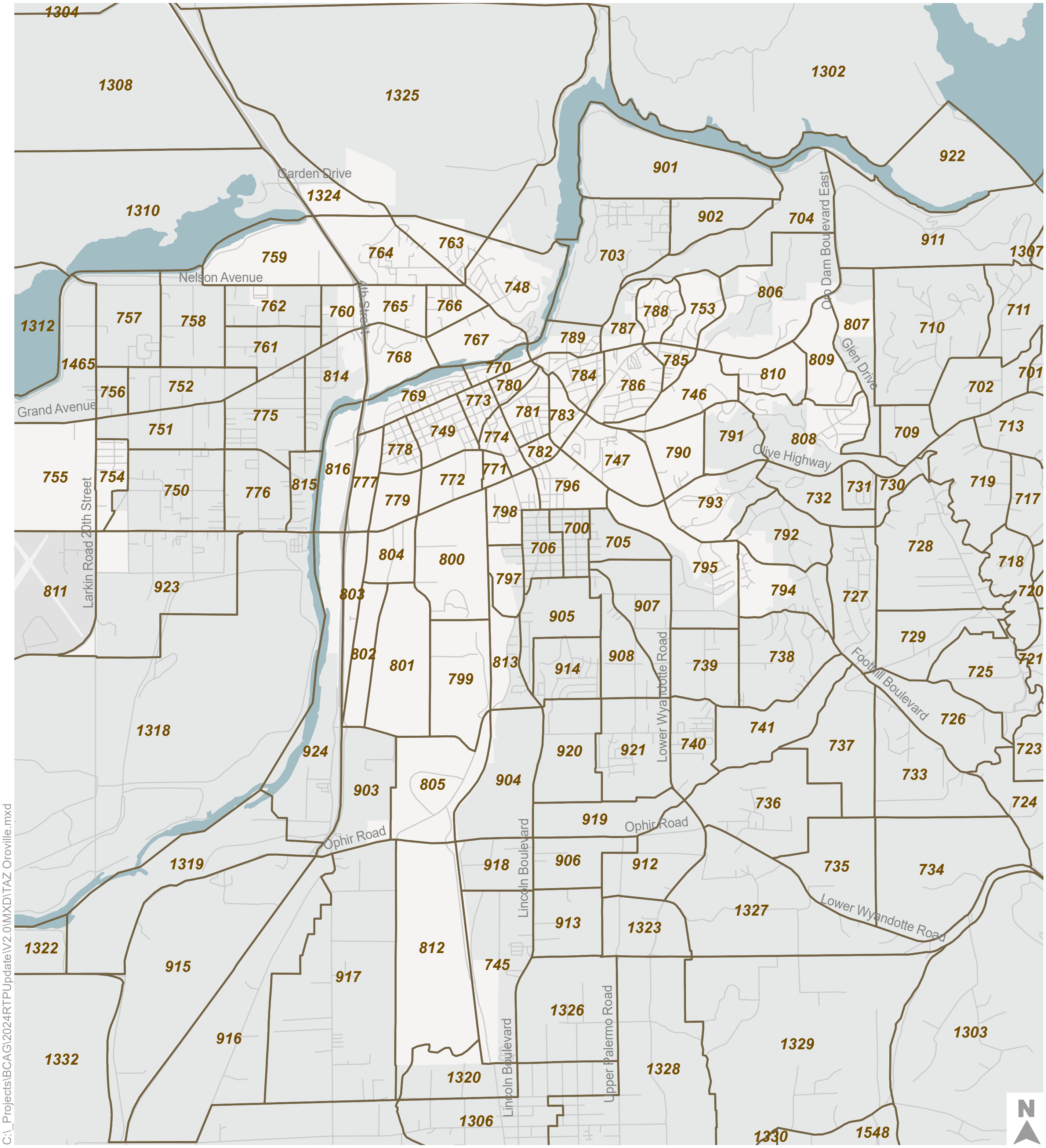
Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Gridley TAZ Boundaries



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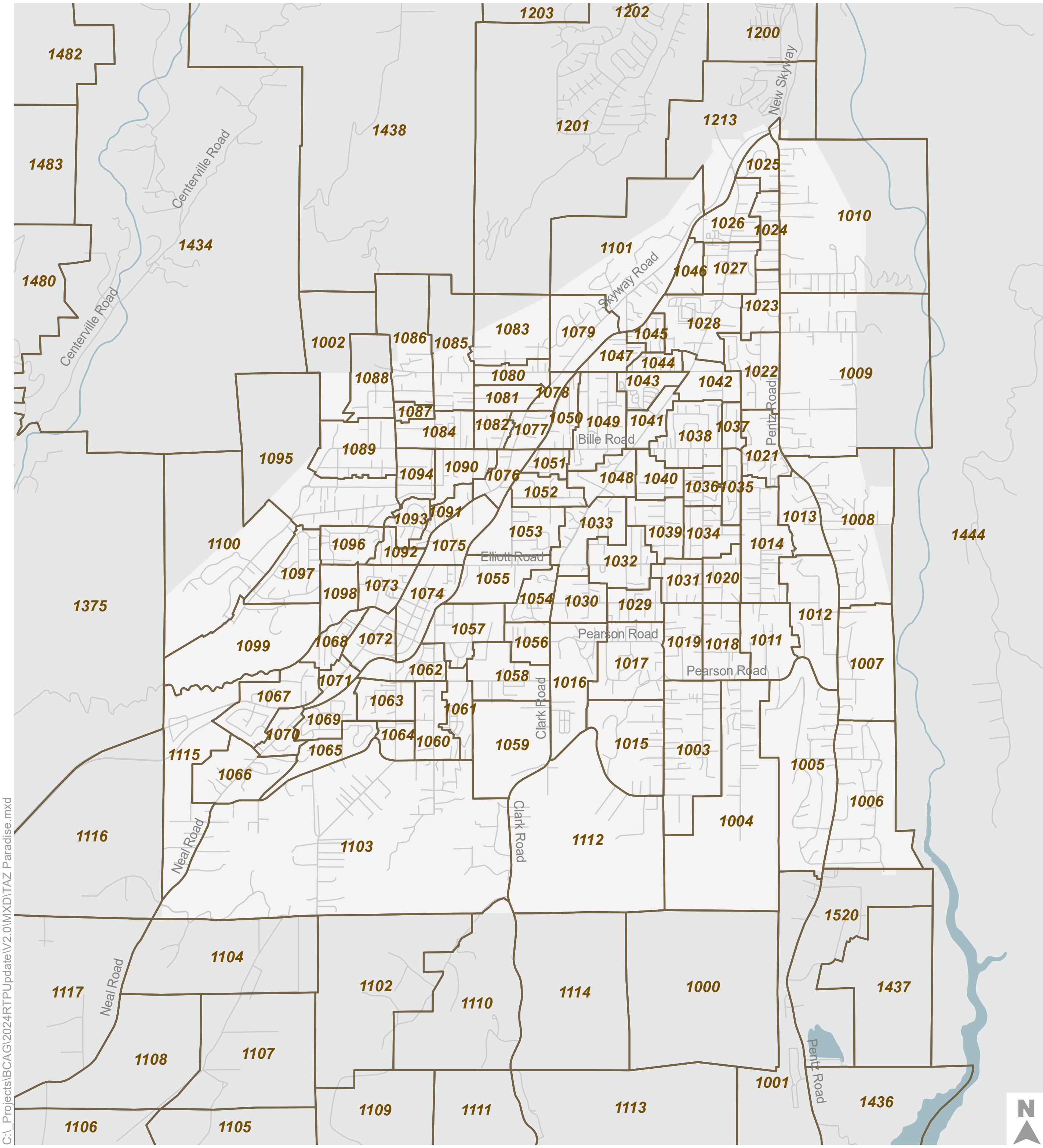
Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Oroville TAZ Boundaries



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Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Paradise TAZ Boundaries

Appendix B:
California Household Travel Survey Data

This appendix contains metadata and data from the CHTS that were used for overall comparisons and validation for the 2018 BCAG TDF Model.

CHTS Detailed Summaries

The tables below contain the metadata for the results of the CHTS processing. The raw summary files are included with the model files and the data used for validation are summarized in the 2018 BCAG Model Validation spreadsheet. Since the model was validated to the county level data, the warning levels are provided for the potential use at a more detailed level.

Table 1: Daily Trip Mode Shares – Metadata

Label	Field Type	Description	Notes
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Trips (all purposes)	Numeric	Total number of person-trips in this geography.	
Sample Trips (all purposes)	Numeric	Number of person-trips surveyed by CHTS in this geography	
Warning Level (all purposes)	Numeric (0, 1, 2)	Warning level 0: All-purpose mode shares can be used with confidence. Warning level 1: All-purpose mode shares should be used with caution and cross-referenced with other sources. Warning level 2: All-purpose mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (all trips)	Percentage	Percentage of drive-alone trips among all trips within the geography.	
Shared Ride 2 mode share (all trips)	Percentage	Percentage of 2-person carpool trips among all trips within the geography.	
Shared Ride 3+ mode share (all trips)	Percentage	Percentage of 3-or-more person carpool trips among all trips within the geography.	
Transit mode share (all trips)	Percentage	Percentage of transit trips among all trips within the geography.	
Bike mode share (all trips)	Percentage	Percentage of bike trips among all trips within the geography.	
Walk mode share (all trips)	Percentage	Percentage of walk trips among all trips within the geography.	
Other mode share (all trips)	Percentage	Percentage of other mode trips among all trips within the geography.	

Table 1: Daily Trip Mode Shares – Metadata			
Label	**Field Type**	**Description**	**Notes**
Total Trips (HBO trips)	Numeric	Total number of HBO person-trips in this geography.	
Sample Trips (HBO trips)	Numeric	Number of HBO person-trips surveyed by CHTS in this geography	
Warning Level (HBO trips)	Numeric (0, 1, 2)	Warning level 0: HBO mode shares can be used with confidence. Warning level 1: HBO mode shares should be used with caution and cross-referenced with other sources. Warning level 2: HBO mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (HBO)	Percentage	Percentage of drive-alone trips among HBO trips within the geography.	
Shared Ride 2 mode share (HBO)	Percentage	Percentage of 2-person carpool trips among HBO trips within the geography.	
Shared Ride 3+ mode share (HBO)	Percentage	Percentage of 3-or-more person carpool trips among HBO trips within the geography.	
Transit mode share (HBO)	Percentage	Percentage of transit trips among HBO trips within the geography.	
Bike mode share (HBO)	Percentage	Percentage of bike trips among HBO trips within the geography.	
Walk mode share (HBO)	Percentage	Percentage of walk trips among HBO trips within the geography.	
Other mode share (HBO)	Percentage	Percentage of other mode trips among HBO trips within the geography.	Other modes include school bus, taxi, private shuttles, etc.
Total Trips (HBW trips)	Numeric	Total number of HBW person-trips in this geography.	
Sample Trips (HBW trips)	Numeric	Number of HBW person-trips surveyed by CHTS in this geography	
Warning Level (HBW trips)	Numeric (0, 1, 2)	Warning level 0: HBW mode shares can be used with confidence. Warning level 1: HBW mode shares should be used with caution and cross-referenced with other sources. Warning level 2: HBW mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (HBW)	Percentage	Percentage of drive-alone trips among HBW trips within the geography.	
Shared Ride 2 mode share (HBW)	Percentage	Percentage of 2-person carpool trips among HBW trips within the geography.	

Table 1: Daily Trip Mode Shares – Metadata			
Label	**Field Type**	**Description**	**Notes**
Shared Ride 3+ mode share (HBW)	Percentage	Percentage of 3-or-more person carpool trips among HBW trips within the geography.	
Transit mode share (HBW)	Percentage	Percentage of transit trips among HBW trips within the geography.	
Bike mode share (HBW)	Percentage	Percentage of bike trips among HBW trips within the geography.	
Walk mode share (HBW)	Percentage	Percentage of walk trips among HBW trips within the geography.	
Other mode share (HBW)	Percentage	Percentage of other mode trips among HBW trips within the geography.	Other modes include school bus, taxi, private shuttles, etc.
Total Trips (NHB trips)	Numeric	Total number of NHB person-trips in this geography.	
Sample Trips (NHB trips)	Numeric	Number of NHB person-trips surveyed by CHTS in this geography	
Warning Level (NHB trips)	Numeric (0, 1, 2)	Warning level 0: HBO mode shares can be used with confidence. Warning level 1: HBO mode shares should be used with caution and cross-referenced with other sources. Warning level 2: HBO mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (NHB)	Percentage	Percentage of drive-alone trips among NHB trips within the geography.	
Shared Ride 2 mode share (NHB)	Percentage	Percentage of 2-person carpool trips among NHB trips within the geography.	
Shared Ride 3+ mode share (NHB)	Percentage	Percentage of 3-or-more person carpool trips among NHB trips within the geography.	
Transit mode share (NHB)	Percentage	Percentage of transit trips among NHB trips within the geography.	
Bike mode share (NHB)	Percentage	Percentage of bike trips among NHB trips within the geography.	
Walk mode share (NHB)	Percentage	Percentage of walk trips among NHB trips within the geography.	
Other mode share (NHB)	Percentage	Percentage of other mode trips among NHB trips within the geography.	Other modes include school bus, taxi, private shuttles, etc.

Table 2: Daily Vehicle Trip Metrics per Household – Metadata			
Label	**Field Type**	**Description**	**Notes**
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Households	Numeric	Total number of households in this geography	CHTS is weighted at county level to match household totals from 2012 5-year ACS. For city geography, this total reflects the CHTS city households, weighted and expanded.
Sample Households	Numeric	Number of households surveyed by CHTS in this geography	
Warning Level	Numeric (0, 1, 2)	Warning level 0: Household metrics can be used with confidence. Warning level 1: Household metrics should be used with caution and cross-referenced with other sources. Warning level 2: Household metrics should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 households; warning level 1: 51-100 households; warning level 2: 50 or fewer households.
VMT per Household, total	Numeric	Vehicle Miles Travelled generated per household, all trip purposes.	
VMT per Household, HBO	Numeric	Vehicle Miles Travelled generated per household, Home-Based Other trips only.	
VMT per Household, HBW	Numeric	Vehicle Miles Travelled generated per household, Home-Based Work trips only.	
VMT per Household, NHB	Numeric	Vehicle Miles Travelled generated per household, Non-Home-Based trips only.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, all trip purposes.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, Home-Based Other trips only.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, Home-Based Work trips only.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, Non-Home-Based trips only.	
Vehicle Trip Length, Total	Numeric	Average Vehicle Trip distance, all trip purposes.	Calculation: Total VMT per HH / Total VT per HH
Vehicle Trip Length, HBO	Numeric	Average Vehicle Trip distance, Home-Based Other trips only.	Calculation: HBO VMT per HH / HBO VT per HH
Vehicle Trip Length, HBW	Numeric	Average Vehicle Trip distance, Home-Based Work trips only.	Calculation: HBW VMT per HH / HBW VT per HH
Vehicle Trip Length, NHB	Numeric	Average Vehicle Trip distance, Non-Home-Based trips only.	Calculation: NHB VMT per HH / NHB VT per HH

Table 3: Daily Vehicle Trip Metrics per Capita – Metadata			
Label	**Field Type**	**Description**	**Notes**
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Persons	Numeric	Total number of persons living in capitas in this geography	Persons not living in capitas (e.g., persons living in group quarters such as university dorms) are not included in this total. CHTS is weighted by capitas at county level to match capita totals from 2012 5-year ACS. For city geography, this total reflects the CHTS city persons, weighted and expanded.
Sample Persons	Numeric	Number of persons in CHTS-surveyed capitas in this geography	
Warning Level	Numeric (0, 1, 2)	Warning level 0: Capita metrics can be used with confidence. Warning level 1: Capita metrics should be used with caution and cross-referenced with other sources. Warning level 2: Capita metrics should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 persons; warning level 1: 51-100 persons; warning level 2: 50 or fewer persons.
VMT per Capita, total	Numeric	Vehicle Miles Travelled generated per capita, all trip purposes.	
VMT per Capita, HBO	Numeric	Vehicle Miles Travelled generated per capita, Home-Based Other trips only.	
VMT per Capita, HBW	Numeric	Vehicle Miles Travelled generated per capita, Home-Based Work trips only.	
VMT per Capita, NHB	Numeric	Vehicle Miles Travelled generated per capita, Non-Home-Based trips only.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, all trip purposes.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, Home-Based Other trips only.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, Home-Based Work trips only.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, Non-Home-Based trips only.	
Vehicle Trip Length, Total	Numeric	Average Vehicle Trip distance, all trip purposes.	Calculation: Total VMT per capita / Total VT per capita
Vehicle Trip Length, HBO	Numeric	Average Vehicle Trip distance, Home-Based Other trips only.	Calculation: HBO VMT per capita / HBO VT per capita

Table 3: Daily Vehicle Trip Metrics per Capita – Metadata			
Label	**Field Type**	**Description**	**Notes**
Vehicle Trip Length, HBW	Numeric	Average Vehicle Trip distance, Home-Based Work trips only.	Calculation: HBW VMT per capita / HBW VT per capita
Vehicle Trip Length, NHB	Numeric	Average Vehicle Trip distance, Non-Home-Based trips only.	Calculation: NHB VMT per capita / NHB VT per capita

Table 4: Daily Person Trip Metrics per Household – Metadata			
Label	**Field Type**	**Description**	**Notes**
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Households	Numeric	Total number of households in this geography	CHTS is weighted at county level to match household totals from 2012 5-year ACS. For city geography, this total reflects the CHTS city households, weighted and expanded.
Sample Households	Numeric	Number of households surveyed by CHTS in this geography	
Warning Level	Numeric (0, 1, 2)	Warning level 0: Household metrics can be used with confidence. Warning level 1: Household metrics should be used with caution and cross-referenced with other sources. Warning level 2: Household metrics should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 households; warning level 1: 51-100 households; warning level 2: 50 or fewer households.
PMT per Household, total	Numeric	Person Miles Travelled generated per household, all trip purposes.	
PMT per Household, HBO	Numeric	Person Miles Travelled generated per household, Home-Based Other trips only.	
PMT per Household, HBW	Numeric	Person Miles Travelled generated per household, Home-Based Work trips only.	
PMT per Household, NHB	Numeric	Person Miles Travelled generated per household, Non-Home-Based trips only.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, all trip purposes.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, Home-Based Other trips only.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, Home-Based Work trips only.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, Non-Home-Based trips only.	
Person Trip Length, Total	Numeric	Average Person Trip distance, all trip purposes.	Calculation: Total PMT per HH / Total PT per HH
Person Trip Length, HBO	Numeric	Average Person Trip distance, Home-Based Other trips only.	Calculation: HBO PMT per HH / HBO PT per HH
Person Trip Length, HBW	Numeric	Average Person Trip distance, Home-Based Work trips only.	Calculation: HBW PMT per HH / HBW PT per HH
Person Trip Length, NHB	Numeric	Average Person Trip distance, Non-Home-Based trips only.	Calculation: NHB PMT per HH / NHB PT per HH

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
All Trips	Trip Data	Total Trips	121,791,338	7,591,534	704,387
		Sample Trips	248,398	12,657	2,055
		Warning Level	0	0	0
	Mode Share, all trips	Drive Alone	40.1%	42.9%	42.9%
		Shared Ride 2	22.6%	23.3%	27.8%
		Shared Ride 3+	20.1%	20.9%	18.1%
		Transit	3.6%	2.0%	3.1%
		Bike	1.6%	2.8%	2.1%
		Walk	10.9%	7.1%	5.6%
		Other	1.0%	1.0%	0.3%
HBO Trips	Trip Data	Total Trips	17,630,532	1,055,514	92,052
		Sample Trips	39,865	1,974	311
		Warning Level	0	0	0
	Mode Share, HBO trips	Drive Alone	30.2%	33.1%	31.5%
		Shared Ride 2	25.4%	25.8%	29.9%
		Shared Ride 3+	24.6%	26.7%	23.8%
		Transit	3.3%	1.2%	4.7%
		Bike	1.8%	3.6%	3.0%
		Walk	13.3%	8.2%	6.7%
		Other	1.4%	1.5%	0.3%
HBW Trips	HBW Trips	Total Trips	68,518,400	4,393,210	392,226
		Sample Trips	135,701	6,892	1,066
		Warning Level	0	0	0
	Mode Share, HBW trips	Drive Alone	76.1%	76.8%	79.7%
		Shared Ride 2	7.9%	6.0%	15.5%
		Shared Ride 3+	2.4%	3.9%	0.8%
		Transit	8.1%	7.6%	2.2%
		Bike	1.9%	3.0%	1.7%
		Walk	3.4%	2.1%	0.0%
		Other	0.2%	0.6%	0.0%
NHB Trips	NHB Trips	Total Trips	35,642,406	2,142,810	220,108
		Sample Trips	72,832	3,791	678
		Warning Level	0	0	0
	Mode Share, NHB trips	Drive Alone	41.5%	46.3%	47.6%
		Shared Ride 2	24.5%	26.6%	29.2%
		Shared Ride 3+	20.4%	17.6%	15.3%
		Transit	0.8%	1.1%	0.7%
		Bike	2.1%	1.1%	0.7%
		Walk	10.1%	7.1%	6.1%
		Other	0.6%	0.2%	0.3%

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Household Metrics		Total Households	12,465,947	816,939	85,074
		Sample Households	30,215	1,438	222
		Warning Level	0	0	0
Daily Vehicle Trip Metrics	VMT per Househo	Total	41.6	42.9	39.3
		HBO	15.4	18.1	15.8
		HBW	14.1	12.4	8.7
		NHB	11.2	11.6	14.3
	e Trips per Hou	Total	5.3	5.3	4.8
		HBO	2.5	2.6	2.2
		HBW	1.2	1.1	0.9
		NHB	1.6	1.6	1.7
	ge Vehicle Trip l	Total	7.9	8.1	8.3
		HBO	6.1	6.9	7.1
		HBW	12.2	11.6	9.4
		NHB	6.9	7.2	8.6

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Capita Metrics		Total Persons	34,153,524	2,120,050	195,774
		Sample Persons	77,587	3,648	534
		Warning Level	0	0	0
Daily Vehicle Trip Metrics	VMT per Capita	Total	15.1	16.6	17.2
		HBO	5.8	7.2	7.0
		HBW	5.1	4.7	3.8
		NHB	4.2	4.6	6.4
	Vehicle Trips per Capita	Total	2.0	2.1	2.1
		HBO	1.0	1.1	1.0
		HBW	0.4	0.4	0.4
		NHB	0.6	0.6	0.7
	Average Vehicle Trip Length	Total	7.6	7.9	8.1
		HBO	6.0	6.8	7.1
		HBW	12.1	11.5	9.3
		NHB	6.8	7.2	8.6

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Household Metrics		Total Households	12,465,947	816,939	85,074
		Sample Households	30,215	1,438	222
		Warning Level	0	0	0
Daily Person Trip Metrics	PMT per Household	Total	63.0	69.3	58.7
		HBO	28.0	36.6	26.8
		HBW	17.0	14.9	10.0
		NHB	16.7	16.4	21.3
	Person Trips per Household	Total	8.9	8.5	7.5
		HBO	4.9	4.9	4.2
		HBW	1.4	1.3	1.0
		NHB	2.6	2.4	2.4
	Average Person Trip Length	Total	7.1	8.1	7.8
		HBO	5.7	7.5	6.4
		HBW	11.8	11.4	9.7
		NHB	6.4	6.9	8.8

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Capita Metrics		Total Persons	34,153,524	2,120,050	195,774
		Sample Persons	77,587	3,648	534
		Warning Level	0	0	0
Daily Person Trip Metrics	PMT per Capita	Total	22.4	26.2	25.1
		HBO	10.2	14.1	11.7
		HBW	6.1	5.7	4.4
		NHB	6.2	6.4	9.2
	Person Trips per Capita	Total	3.3	3.3	3.3
		HBO	1.8	1.9	1.8
		HBW	0.5	0.5	0.5
		NHB	1.0	0.9	1.1
	Average Person Trip Length	Total	6.8	7.9	7.7
		HBO	5.6	7.4	6.4
		HBW	11.8	11.4	9.7
		NHB	6.4	6.8	8.7

Appendix C:
Auto Operating Cost Estimations

Auto Operation Cost Calculator (Draft For Comments Only)

Select MPO	BCAG
Select Calendar Year	2022

	GASOLINE			DIESEL			ELECTRIC			HYDROGEN			PHEV		
		Value			Value			Value			Value			Value	
	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom
Fuel Cost (dollar/gasoline gallon equivalent)[1]	Default	3.72		Default	3.55		Default	6.48		Default	13.91			5.03	5.03
Non-fuel Cost (cents per mile) [2]	Default	7.95		Default	7.95		Default	6.55		Default	7.95			6.99	6.99
VMT	Default	5,200,045		Default	72,536		Default	25,451		Default	6,917		Default	63,454	
Fuel Efficiency (mile/gasoline gallon equivlent)	Gasoline	27.34		Diesel	37.55		Electric	116.01		Hydrogen	75.53		PHEV	59.24	
Auto Operating Cost by Fuel Type (Cents/Mile)	Gasoline	21.56		Diesel	17.40		Electric	12.14		Hydrogen	26.36		PHEV	14.37	

Calendar Year	2022
Auto Operating Cost (Cents/Mile)	21.38

Steps:
1. Select MPO and Calender Year from the drop-down list.
2. Select "Default" or "Custom" mode for each parameter from the drop-down list
3. Enter custom value(s) after selecting "Custom" mode for fuel cost, non-fuel cost and VMT

Note:
1- Input as 2017 dollars/cents
2- Include maintenace, repair and tire cost

Auto Operation Cost Calculator **(Draft For Comments Only)**

Select MPO	BCAG
Select Calendar Year	2035

	GASOLINE			DIESEL			ELECTRIC			HYDROGEN			PHEV		
		Value			Value			Value			Value			Value	
	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom
Fuel Cost (dollar/gasoline gallon equivalent)[1]	Default	4.18		Default	4.16		Default	6.61		Default	10.32			5.53	5.53
Non-fuel Cost (cents per mile) [2]	Default	7.95		Default	7.95		Default	6.55		Default	7.95			6.99	6.99
VMT	Default	5,634,462		Default	80,964		Default	106,950		Default	56,598		Default	223,976	
Fuel Efficiency (mile/gasoline gallon equivlent)	Gasoline	36.82		Diesel	48.32		Electric	135.64		Hydrogen	88.65		PHEV	76.28	
Auto Operating Cost by Fuel Type (Cents/Mile)	Gasoline	19.31		Diesel	16.56		Electric	11.42		Hydrogen	19.60		PHEV	13.47	

Calendar Year	2035
Auto Operating Cost (Cents/Mile)	18.92

Steps:

1. Select MPO and Calender Year from the drop-down list.
2. Select "Default" or "Custom" mode for each parameter from the drop-down list
3. Enter custom value(s) after selecting "Custom" mode for fuel cost, non-fuel cost and VMT

Note:

1- Input as 2017 dollars/cents

2- Include maintenace, repair and tire cost

Auto Operation Cost Calculator (Draft For Comments Only)

Select MPO	BCAG
Select Calendar Year	2045

	GASOLINE			DIESEL			ELECTRIC			HYDROGEN			PHEV		
	Data Source	Value		Data Source	Value		Data Source	Value		Data Source	Value		Data Source	Value	
		Default	Custom		Default	Custom		Default	Custom		Default	Custom		Default	Custom
Fuel Cost (dollar/gasoline gallon equivalent)[1]	Default	4.18		Default	4.16		Default	6.61		Default	10.32			5.55	5.55
Non-fuel Cost (cents per mile) [2]	Default	7.95		Default	7.95		Default	6.55		Default	7.95			6.99	6.99
VMT	Default	5,941,511		Default	85,372		Default	130,128		Default	71,794		Default	265,662	
Fuel Efficiency (mile/gasoline gallon equivlent)	Gasoline	38.97		Diesel	50.72		Electric	151.82		Hydrogen	100.56		PHEV	80.93	
Auto Operating Cost by Fuel Type (Cents/Mile)	Gasoline	18.68		Diesel	16.15		Electric	10.90		Hydrogen	18.22		PHEV	13.06	

Calendar Year	2045
Auto Operating Cost (Cents/Mile)	18.25

Steps:
1. Select MPO and Calender Year from the drop-down list.
2. Select "Default" or "Custom" mode for each parameter from the drop-down list
3. Enter custom value(s) after selecting "Custom" mode for fuel cost, non-fuel cost and VMT

Note:
1- Input as 2017 dollars/cents
2- Include maintenace, repair and tire cost

Appendix D:

Planned and Programmed Project List

Capacity Projects 2022-2045 (2024 RTP/SCS) - Scenario #4

Jurisdiction	TITLE	PROJECT DESCRIPTION	New Lane Miles	Roadway Classification	Speed	2024 RTP Analysis Year		
						2022 - Model Base Year	2035 GHG Year	2045 RTP Horizon
Butte County	Central House Rd Bridge Widening (at Wyman Ravine)	Widen Central House Rd Bridge from 1 to 2 lanes at Wyman Ravine	0.04	Local	35		x	x
Butte County	SR 70 Widening (Lower Honcut Rd to Butte County Line)	Widen SR 70 from 2 to 4 lanes from Lower Honcut Rd to Butte County Line.	2.02	Principal Arterial	65		x	x
Chico	Guynn Rd Bridge Widening (at Lindo Channel)	Widen Guynn Rd Bridge from 1 to 2 lanes at Lindo Channel	0.03	Local	25		x	x
Chico	Cohasset Rd Widening (Airport Blvd to Eaton Rd)	Widen Cohassett Rd from 2 to 4 lanes from Airport Blvd to Eaton Rd	3.61	Minor Arterial	55		x	x
Chico	Bruce Rd Widening (Skyway to SR 32)	From Skyway to SR 32, widen Roadway (Bridge included as separate project)	4.09	Minor Arterial	45		x	x
Chico	Commerce Ct Extension (Ivy St to Park Ave)	Construct 2 lane roadway connecting Ivy St to Park Ave	0.06	Local	25		x	x
Chico	E. 20th St Widening (Notre Dame Blvd to Bruce Rd)	Widen E. 20th St from 3 to 4 lanes from Notre Dame Blvd to Bruce Rd	0.48	Minor Arterial	40			x
Chico	Eaton Rd Widening (Hicks Ln to Cohasset Rd)	Widen Eaton Rd from 2 to 4 lanes from Hicks Ln to Cohasset Rd	3.05	Minor Arterial	45			x
Chico	Eaton Rd Widening (Ceanothus Ave to Marogold Ave)	Widen Eaton Rd from 3 to 4 lanes from Ceanothus Ave to Marigold Ave	0.25	Minor Arterial	45			x
Chico	Eaton Rd Widening (Cohasset to Lassen Ave)	Widen Eaton Rd from 2 to 4 lanes from Cohasset Rd to Lassen Ave	1.26	Minor Arterial	40			x
Chico	Eaton Rd Widening (Marigold Ave to Lance Terr)	Widen Eaton Rd from 3 to 4 lanes from Marigold Ave to Lance Terr	0.52	Minor Arterial	45			x
Chico	Esplanade Widening (Eaton Rd to Nord Hwy)	Widen Esplanade from 2 to 4 lanes from Eaton Rd to Nord Hwy	1.34	Major Collector	35		x	x
Chico	Yosemite Dr extension (Native Oak Dr to Humboldt Rd)	Construct 2 lane roadway connecting Native Oak Dr to Humboldt Rd	0.31	Major Collector	35		x	x
Chico	Notre Dame Extension (@ Little Chico Creek)	Construct 2 lane bridge @ Little Chico Creek	0.16	Major Collector	25		x	x
Chico	Midway Widening (Hegan Ln to E. Park Ave)	Widen Midway from 2 to 4 lanes from Hegan Ln to E. Park Ave	0.86	Minor Arterial	45			x
Chico	SR 32 Widening (El Monte Ave to Bruce Rd)	Widen SR 32 from 2 to 4 lanes from El Monte Ave to Bruce Rd	0.89	Principal Arterial	55			x
Chico	SR 32 Widening (Bruce Rd to Yosemite Dr)	Widen SR 32 from 2 to 4 lanes from Bruce Rd to Yosemite Dr	1.32	Minor Arterial	55			x
Chico	Eaton Rd Widening (@ SR 99)	Widen Eaton Rd from 2 to 4 lanes from Esplanade to SR 99	0.33	Minor Arterial	35		x	x
Chico	SR 99 on-ramp at Cohasset Rd	Construct Southbound direct on-ramp	0.12	Principal Arterial	65			x
Chico	MLK Blvd Widening (E. Park Ave to 20th St)	Widen MLK Blvd from 2 to 4 lanes from E. Park Ave to 20th St	1.62	Major Collector	35			x
Chico	Fair St Lane Reduction (E. Park Ave to E 20th St)	Reduce vehicle travel lanes from 4 to 2 from E. Park Ave to 20th St	-1.38	Principal Arterial	35		x	x
Paradise	Roe Rd Extension (Pentz Rd to S. Libby Rd) - Phase 1	Construct 2 lane roadway for extension of Roe Rd from Pentz Rd to South Libby Rd	2.28	Major Collector	25		x	x
Paradise	Roe Rd Extension (S. Libby Rd to SR 191) - Phase 2	Construct 2 lane roadway for extension of Roe Rd from South Libby Rd to SR 191	0.79	Major Collector	25		x	x
Paradise	Roe Rd Extension (SR 191 to Scottwood Rd) - Phase 3	Construct 2 lane roadway for extension of Roe Rd from SR 191 to Scottwood Rd	1.02	Major Collector	25		x	x
Paradise	Roe Rd Extension (Neal Rd to Skyway) - Phase 4	Construct 2 lane roadway for extension of Roe Rd from Neal Rd to Skyway	0.86	Major Collector	25			x

Bike Network Updates 2022-2045 (2024 RTP/SCS) - Scenario #4

Jurisdiction	TITLE	PROJECT DESCRIPTION	Facility Miles	Facility Classification	2024 RTP Analysis Year		
					2022 - Model Base Year	2035 GHG Year	2045 RTP Horizon
Biggs	SR2S 2nd St Class II	Class II along 2nd & E Streets.	0.32	Class II		x	x
Butte County	Autry Lane & Monte Vista Safe Routes to Schools Gap Closure Project	Curb, gutter, sidewalk, and crossing enhancements along Autrey Ln. and Monte Vista Ave. on Autry from Las Plumas to Monte Vista and along Monte Vista from Autry Ln to Lincoln Blvd.	3.15	Class II		x	x
Butte County	State Route 162 Class II	Class II along SR 162 from Monument Hill Rd to Wildlife Area Rd	4.38	Class II		x	x
Butte County	Noth Chico Specific Plan Area Class I & II	Class I bike facilities consistent with North Chico Specific Plan	2.73	Class I		x	x
		Class II bike facilities consistent with North Chico Specific Plan	1.55	Class II		x	x
Butte County	Rio D' Oro Specific Plan Area Class I & II - Phase 1	Class I bike facilities consistent with Rio D' Oro Specific Plan - Phase 1	1.03	Class I		x	x
		Class II bike facilities consistent with Rio D' Oro Specific Plan - Phase 1	0.38	Class II		x	x
Chico	SR 99 Corridor Bikeway Phase 5 - 20th Street Crossing	SR 99 Corridor Bikeway Project Phase 5 completes the gap adjacent to SR 99 from Chico Mall across 20th Street to the south end of Business Lane. Scope of project is develop a new bicycle and pedestrian crossing (bridge) over 20th Street in Chico.	0.49	Class IV		x	x
Chico	Whittmeier Dr Class II (Bikeway 99 connector)	From SR99 Phase 4 end to Forest Ave and Talbert. Class 2 bike facility (0.18 miles)	0.19	Class II		x	x
Chico	Humboldt Rd Class 1	From Morning Rose Way to Bruce Rd. Class 1 bike facility (0.51 miles)	0.56	Class I		x	x
Chico	Esplanade Class 1	From Eaton Rd to Nord Hwy. Class 1 bike facility (0.67 miles)	0.67	Class I		x	x
Chico	Esplanade Class 2	From W 11th Ave to East Ave. Class 2 bike facility (1.09 miles)	1.20	Class II		x	x
Chico	Bruce Rd Class 1	From HWY 32 to Remington Dr. Class 1 bike facility (0.65 miles)	0.99	Class I		x	x
Chico	Lower Bidwell Park - Downtown Chico Connection	Class II buffered bike lanes along E 4th St from Main St to Cypress St and along E 3rd St from Main St to Pine St.	0.73	Class II		x	x
Chico	Chico Station - Downtown Chico Connection	Class II buffered bike lanes along W 4th St from Orange St to Main St and along W 3rd St from Walnut St to Main St.	1.18	Class II		x	x
Chico	Vallombrosa Avenue Bikeway	Class IV bikeway along Vallombrosa Ave from Manzanita Ave to Camellia Way.	2.85	Class IV		x	x
Chico	Chico River Road to Downtown Chico Connection	Class II bike lane along W 5th St from Chico River Rd to Broadway St	0.94	Class II		x	x
Chico	Lindo Channel Bikepath	Class I shared-use path along Lindo Channel from Nord Ave to SR99.	2.65	Class I		x	x
Chico	Little Chico Creek Bikepath	Class I shared-use path along Little Chico Creek from Pomona Ave to SR99.	2.12	Class I		x	x
Chico	Vallombrosa - Manzanita Connection	Class I shared-use path along SR99 from Vallombrosa Ave to Manzanita Ave.	1.11	Class I		x	x

Chico	Mangrove Avenue Bike Improvements	Class II buffered bike lane along Mangrove Ave from Pine St/Cypress St to Cohasset Rd.	1.48	Class II		x	x
Chico	East 1st Avenue/Longfellow Avenue Bike Improvements	Class II buffered bike lane on East 1st/Longfellow Ave from Esplanade to Manzanita Ave.	1.60	Class II		x	x
Chico	Downtown Chico Complete Streets Project	Class IV parking-buffered bikeway along Main St from E 9th St to E 1st St	0.54	Class IV		x	x
		Class IV bikeway along Main St from E 1st St to Main St end.	0.17	Class IV		x	x
		Class II bike lanes along Broadway St from W 1st St to W 9th St.	0.52	Class II		x	x
Chico	Cohasset Road Bikeway	Class IV bikeway along Cohasset Rd from Manzanita Ct to Eaton Rd.	1.65	Class IV		x	x
Chico	Annie's Glen Bike Path Connector	Class I shared-use path at Annie's Glen bike path access point connector from south of Vallombrosa to Mangrove Ave/Annie's Glen bike path.	0.10	Class I		x	x
Chico	Nord Avenue Bikeway	Construct Class IV bikeway along Nord Ave from W Sacramento Ave to W 8th Ave	0.69	Class IV		x	x
Chico	Wall Street Bike Improvements	Class I shared-use path along Wall St from E 4th St to E 5th St.	0.06	Class I		x	x
Chico	W. Sacramento Avenue Bike Improvements	Class II buffered bike lane with green paint along W Sacramento Ave from Warner St to Esplanade.	0.42	Class II		x	x
Chico	Eaton Rd Widening - Class IV bike path	Class IV bike path along Eatn Rd from SR 99 to Cohasset Rd	1.52	Class IV			x
Chico	Notre Dame Boulevard Connection - Class II	Class II bike lane along Notre Dame Blvd over Little Chico Creek	0.10	Class II		x	x
Chico	Midway Class II	Class II bike lane along Midway Aver from Hegan Ln to E Park Ave	0.43	Class II		x	x
Chico	Yosemite Dr Class I	Class I bike path along Yosemite Dr from Native Oak Dr to Humboldt Rd	0.16	Class I		x	x
Chico	Little Chico Creek Bike Bridge Class I	Class I bike path at new bridge crossing Little Chico Creek near 20th St Park	0.05	Class I		x	x
Chico	Mariposa Ave Class II	Class II bike lane along Mariposa Ave from Eaton Rd to Whitewood Way	0.08	Class II		x	x
Chico	Mulberry, Pine, and Cypress St Class II	Class II along Mulberry, Pine, and Cypress Streets from 9th St to 20th St	0.98	Class II		x	x
Chico	North Cedar St Reconstruction Project	Class II along North Cedar St from W. Sacramento Ave to 4th Ave	0.34	Class II		x	x
Chico	Barber Yard Specific Plan Phase 1	Class I bike facilities consistent with Barber Yard Specific Plan - Phase 1	0.48	Class I		x	x
Chico	Barber Yard Specific Plan Phase 2	Class I bike facilities consistent with Barber Yard Specific Plan - Phase 2	1.12	Class I		x	x
Chico	Barber Yard Specific Plan Phase 3	Class I bike facilities consistent with Barber Yard Specific Plan - Phase 3	0.19	Class I			x
Chico	Valley's Edge Specific Plan Phase 1	Class I bike facilities consistent with Valley's Edge Specific Plan - Phase 1	2.73	Class I			
		Class II bike facilities consistent with Valley's Edge Specific Plan - Phase 1	0.43	Class II			
Chico	Valley's Edge Specific Plan Phase 2	Class I bike facilities consistent with Valley's Edge Specific Plan - Phase 2	2.25	Class I			
Chico	Chico - Paradise Bikeway Project	Class I bike path along Skyway from Honey Run Rd to Paradise Trailway	8.78	Class I		x	x
Chico	Bruce Rd Class 1 (Skyway to 20th St)	Class I bike path along Bruce Rd from Skyway to 20th St	1.06	Class I		x	x

Chico	Fair St Class II (E Park Ave to 20th St)	Class II bike lanes along Fair St from E Park Ave to 20th St	0.69	Class II		x	x
Gridley	Gridley Bike & Pedestrian SR 99 Corridor Facility Project	Class I bike path along State Route 99 from Township Road to Archer Avenue.	0.97	Class I		x	x
Gridley	Magnolia St Class II	From Idaho St to Vermont St. New Class 2 bike facilities (0.42 miles)	0.42	Class II		x	x
Gridley	Gridley Rd Class II	From Jackson St to SR99. New Class 2 bike facilities (0.25 miles)	0.25	Class II		x	x
Oroville	Washington Ave. Complete Streets Project	between Oroville Dam Boulevard East and the railroad bridge just past Orange Avenue. Construct new bike/ped facilities & ADA treatment	0.59	Class II		x	x
Oroville	Table Mountain Boulevard Complete Streets Project	from the Montgomery Street Roundabout to the Thermalito Power Canal. Construct new bike/ped facilities, ADA treatment, gap closures.	1.50	Class II		x	x
Oroville	SR 162 Class II	Class II along SR 162 from Feather River Bridge to Foothill Blvd	2.76	Class II		x	x
Oroville	City of Oroville AHSC Application (24/25)	Class II along Nelson Ave and 2nd St consistent with City of Oroville AHSC Application (24/25)	1.09	Class II		x	x
Paradise	Go Paradise: Oliver-Park Connection Project (AKA Oliver Curve Pathway Phase 1)	Oliver Road between Skyway and Bille Road, Bille Road between Oliver Road and Bille Park. Construct a grade separated, Class I, bike-ped facility along the west side of Oliver Road and north side of Bille Road within the project limits.	1.09	Class I		x	x
Paradise	Go Paradise: Neal Gateway ATP Project (AKA Paradise ATP Gateway Project)	Neal Road between Town Limits and Skyway (1.62 miles). Along Neal Road, construct a grade separated, Class I, bike-ped facility along the west side of Neal Road within the project limits.	1.62	Class I		x	x
Paradise	Pentz Rd Trailway Class I	Class I along Pentz Rd between Pearson Rd and Bille Rd and Wagstaff Rd and Skyway	3.16	Class I		x	x
Paradise	Roe Rd Extension Phase 1 - Class I	Class I along Roe Rd from Pentz Rd to South Libby Ln	1.33	Class I		x	x
Paradise	Roe Rd Extension Phase 2 - Class I	Class I along Roe Rd from South Libby Ln to SR 191	0.80	Class I		x	x
Paradise	Roe Rd Extension Phase 3 - Class I	Class I along Roe Rd from SR 191 to Scottwood Dr	0.76	Class I		x	x
Paradise	Roe Rd Extension Phase 4 - Class I	Class I along Roe Rd from Neal Rd to Skyway	0.43	Class I			x
Paradise	Roe Rd Extension Phase 5 - Class I	Class I along Roe Rd from Scottwood Dr to Neal Rd	1.65	Class I			x
Paradise	Gap Closure Complex Project and Almond St Multimodal	Class I along Almond St from Fir St to Elliott Rd	0.29	Class I		x	x
		Class II along portions of Almond St, Fir St, Birch St, and Black Olive Dr in downtown.	0.67	Class II		x	x
Paradise	Elliott Rd Class II	Class II along Elliot Rd from Skyway to Clark Rd	0.92	Class II		x	x
Paradise	Ponderosa Elementary SRTS - ATP	Class II along Pentz Rd from Bille Rd to Wagstaff Rd	0.60	Class II		x	x
Paradise	Go Paradise - Skyway Link Project (Skyway Connectivity)	The Skyway Link/Skyway Connectivity Project will stripe 3,165 linear feet of on-street bicycle lanes between Wagstaff Road and Bille Road.	0.61	Class II		x	x

Appendix E:
Model Scenario Reporting Tables

Additional Capacity 2022-2045 (2024 RTP/SCS) - Scenario #2

Jurisdiction	TITLE	PROJECT DESCRIPTION	New Lane Miles	Roadway Classification	Speed	2024 RTP Analysis Year		
						2022 - Model Base Year	2035 GHG Year	2045 RTP Horizon
Butte County	Central House Rd Bridge Widening (at Wyman Ravine)	Widen Central House Rd Bridge from 1 to 2 lanes at Wyman Ravine	0.04	Local	35		x	x
Butte County	SR 70 Widening (Lower Honcut Rd to Butte County Line)	Widen SR 70 from 2 to 4 lanes from Lower Honcut Rd to Butte County Line.	2.02	Principal Arterial	65		x	x
Chico	Guynn Rd Bridge Widening (at Lindo Channel)	Widen Guynn Rd Bridge from 1 to 2 lanes at Lindo Channel	0.03	Local	25		x	x
Chico	Cohasset Rd Widening (Airport Blvd to Eaton Rd)	Widen Cohassett Rd from 2 to 4 lanes from Airport Blvd to Eaton Rd	3.61	Minor Arterial	55		x	x
Chico	Bruce Rd Widening (Skyway to SR 32)	From Skyway to SR 32, widen Roadway (Bridge included as separate project)	4.09	Minor Arterial	45		x	x
Chico	Commerce Ct Extension (Ivy St to Park Ave)	Construct 2 lane roadway connecting Ivy St to Park Ave	0.06	Local	25		x	x
Chico	E. 20th St Widening (Forest Ave to Bruce Rd)	Widen E. 20th St from 2 to 4 lanes from Forest Ave to Bruce Rd	0.98	Minor Arterial	40		x	x
Chico	Eaton Rd Widening (Hicks Ln to Cohasset Rd)	Widen Eaton Rd from 2 to 4 lanes from Hicks Ln to Cohasset Rd	2.71	Minor Arterial	45			x
Chico	Eaton Rd Widening (Ceanothus Ave to Marogold Ave)	Widen Eaton Rd from 3 to 4 lanes from Ceanothus Ave to Marigold Ave	0.25	Minor Arterial	45			x
Chico	Eaton Rd Widening (Cohasset to Lassen Ave)	Widen Eaton Rd from 2 to 4 lanes from Cohasset Rd to Lassen Ave	1.26	Minor Arterial	40			x
Chico	Eaton Rd Widening (Marigold Ave to Lance Terr)	Widen Eaton Rd from 3 to 4 lanes from Marigold Ave to Lance Terr	0.52	Minor Arterial	45			x
Chico	Esplanade Widening (Eaton Rd to Nord Hwy)	Widen Esplanade from 2 to 4 lanes from Eaton Rd to Nord Hwy	1.34	Major Collector	35		x	x
Chico	Yosemite Dr extension (Native Oak Dr to Humboldt Rd)	Construct 2 lane roadway connecting Native Oak Dr to Humboldt Rd	0.31	Major Collector	35		x	x
Chico	Notre Dame Extension (@ Little Chico Creek)	Construct 2 lane bridge @ Little Chico Creek	0.16	Major Collector	25		x	x
Chico	Midway Widening (Hegan Ln to E. Park Ave)	Widen Midway from 2 to 4 lanes from Hegan Ln to E. Park Ave	0.86	Minor Arterial	45		x	x
Chico	SR 32 Widening (El Monte Ave to Bruce Rd)	Widen SR 32 from 2 to 4 lanes from El Monte Ave to Bruce Rd	0.89	Principal Arterial	55		x	x
Chico	SR 32 Widening (Bruce Rd to Yosemite Dr)	Widen SR 32 from 2 to 4 lanes from Bruce Rd to Yosemite Dr	1.32	Minor Arterial	55		x	x
Chico	SR 99 Overpass Widening (@ Eaton Rd)	Widen SR 99 overpass at Eaton Rd from 2 to 4 lanes	0.97	Minor Arterial	35		x	x
Chico	SR 99 on-ramp at Cohasset Rd	Construct Southbound direct on-ramp	0.12	Principal Arterial	65		x	x
Chico	MLK Blvd Widening (E. Park Ave to 20th St)	Widen MLK Blvd from 2 to 4 lanes from E. Park Ave to 20th St	1.62	Major Collector	35		x	x
Chico	SR 99 Aux Lanes (20th St to SR 32)	Constuct auxillary lanes on Hwy 99 from 20th st to SR 32	0.78	Freeway	65		x	x
Chico	SR 99 Aux Lanes (Skyway to 20th St)	Constuct auxillary lanes on Hwy 99 from Skyway to 20th St	0.56	Freeway	65		x	x
Oroville	Olive Hwy Widening (Oro-Dam Blvd to Foothill Blvd)	Construct additional eastbound lane on Olive Hwy (SR 162) from Oro-Dam Blvd to Foothill Blvd	0.90	Principal Arterial	35		x	x
Paradise	Roe Rd Extension (Pentz Rd to S. Libby Rd) - Phase 1	Construct 2 lane roadway for extension of Roe Rd from Pentz Rd to South Libby Rd	2.28	Major Collector	25		x	x
Paradise	Roe Rd Extension (S. Libby Rd to SR 191) - Phase 2	Construct 2 lane roadway for extension of Roe Rd from South Libby Rd to SR 191	0.79	Major Collector	25		x	x
Paradise	Roe Rd Extension (SR 191 to Scottwood Rd) - Phase 3	Construct 2 lane roadway for extension of Roe Rd from SR 191 to Scottwood Rd	1.02	Major Collector	25			
Paradise	Roe Rd Extension (Neal Rd to Skyway) - Phase 4	Construct 2 lane roadway for extension of Roe Rd from Neal Rd to Skyway	0.86	Major Collector	25			

Additional Capacity 2022-2045 (2024 RTP/SCS) - Scenario #3

Jurisdiction	TITLE	PROJECT DESCRIPTION	New Lane Miles	Roadway Classification	Speed	2024 RTP Analysis Year		
						2022 - Model Base Year	2035 GHG Year	2045 RTP Horizon
Butte County	Central House Rd Bridge Widening (at Wyman Ravine)	Widen Central House Rd Bridge from 1 to 2 lanes at Wyman Ravine	0.04	Local	35		x	x
Butte County	SR 70 Widening (Lower Honcut Rd to Butte County Line)	Widen SR 70 from 2 to 4 lanes from Lower Honcut Rd to Butte County Line.	2.02	Principal Arterial	65		x	x
Chico	Guynn Rd Bridge Widening (at Lindo Channel)	Widen Guynn Rd Bridge from 1 to 2 lanes at Lindo Channel	0.03	Local	25		x	x
Chico	Cohasset Rd Widening (Airport Blvd to Eaton Rd)	Widen Cohassett Rd from 2 to 4 lanes from Airport Blvd to Eaton Rd	3.61	Minor Arterial	55		x	x
Chico	Bruce Rd Widening (Skyway to SR 32)	From Skyway to SR 32, widen Roadway (Bridge included as separate project)	4.09	Minor Arterial	45		x	x
Chico	Commerce Ct Extension (Ivy St to Park Ave)	Construct 2 lane roadway connecting Ivy St to Park Ave	0.06	Local	25		x	x
Chico	E. 20th St Widening (Forest Ave to Bruce Rd)	Widen E. 20th St from 2 to 4 lanes from Forest Ave to Bruce Rd	0.98	Minor Arterial	40		x	x
Chico	Eaton Rd Widening (Hicks Ln to Cohasset Rd)	Widen Eaton Rd from 2 to 4 lanes from Hicks Ln to Cohasset Rd	3.05	Minor Arterial	45			x
Chico	Eaton Rd Widening (Ceanothus Ave to Marogold Ave)	Widen Eaton Rd from 3 to 4 lanes from Ceanothus Ave to Marigold Ave	0.25	Minor Arterial	45		x	x
Chico	Eaton Rd Widening (Cohasset to Lassen Ave)	Widen Eaton Rd from 2 to 4 lanes from Cohasset Rd to Lassen Ave	1.26	Minor Arterial	40		x	x
Chico	Eaton Rd Widening (Marigold Ave to Lance Terr)	Widen Eaton Rd from 3 to 4 lanes from Marigold Ave to Lance Terr	0.52	Minor Arterial	45		x	x
Chico	Esplanade Widening (Eaton Rd to Nord Hwy)	Widen Esplanade from 2 to 4 lanes from Eaton Rd to Nord Hwy	1.34	Major Collector	35		x	x
Chico	Yosemite Dr extension (Native Oak Dr to Humboldt Rd)	Construct 2 lane roadway connecting Native Oak Dr to Humboldt Rd	0.31	Major Collector	35		x	x
Chico	Notre Dame Extension (@ Little Chico Creek)	Construct 2 lane bridge @ Little Chico Creek	0.16	Major Collector	25		x	x
Chico	Midway Widening (Hegan Ln to E. Park Ave)	Widen Midway from 2 to 4 lanes from Hegan Ln to E. Park Ave	0.86	Minor Arterial	45		x	x
Chico	SR 32 Widening (El Monte Ave to Bruce Rd)	Widen SR 32 from 2 to 4 lanes from El Monte Ave to Bruce Rd	0.89	Principal Arterial	55		x	x
Chico	SR 32 Widening (Bruce Rd to Yosemite Dr)	Widen SR 32 from 2 to 4 lanes from Bruce Rd to Yosemite Dr	1.32	Minor Arterial	55			x
Chico	Eaton Rd Widening (@ SR 99)	Widen Eaton Rd from 2 to 4 lanes from Esplanade to SR 99	0.33	Minor Arterial	35		x	x
Chico	SR 99 on-ramp at Cohasset Rd	Construct Southbound direct on-ramp	0.12	Principal Arterial	65			x
Chico	MLK Blvd Widening (E. Park Ave to 20th St)	Widen MLK Blvd from 2 to 4 lanes from E. Park Ave to 20th St	1.62	Major Collector	35		x	x
Paradise	Roe Rd Extension (Pentz Rd to S. Libby Rd) - Phase 1	Construct 2 lane roadway for extension of Roe Rd from Pentz Rd to South Libby Rd	2.28	Major Collector	25		x	x
Paradise	Roe Rd Extension (S. Libby Rd to SR 191) - Phase 2	Construct 2 lane roadway for extension of Roe Rd from South Libby Rd to SR 191	0.79	Major Collector	25		x	x
Paradise	Roe Rd Extension (SR 191 to Scottwood Rd) - Phase 3	Construct 2 lane roadway for extension of Roe Rd from SR 191 to Scottwood Rd	1.02	Major Collector	25		x	x
Paradise	Roe Rd Extension (Neal Rd to Skyway) - Phase 4	Construct 2 lane roadway for extension of Roe Rd from Neal Rd to Skyway	0.86	Major Collector	25			x

Modeling Data	2022	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)	2045
Vehicle Operating Costs ($/mile)	0.214	0.189	0.189	0.189	0.189	0.183
Average Auto Trip Length (miles)	7.13	7.76	7.21	7.22	7.24	7.29
Average Auto Travel Time (minutes)	10.47	11.37	10.67	10.55	10.54	10.59
Percent Passenger Travel Mode Share						
Auto	91.7%	89.3%	89.5%	89.2%	87.6%	87.4%
SOV	48.3%	47.8%	46.3%	45.9%	45.0%	44.8%
HOV	43.4%	41.5%	43.3%	43.3%	42.7%	42.6%
All Other (transit & non-motorized)	8.3%	10.7%	10.5%	10.8%	12.4%	12.6%
Public Transit (Fixed Route Bus)	1.7%	3.9%	3.4%	3.5%	4.7%	4.8%
Non-Motorized (Bike and Walk)	6.4%	6.5%	6.8%	7.0%	7.4%	7.5%
Other (i.e. School Bus)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%

Butte County VMT Summary

Scenario	II VMT	IX-XI VMT	XX VMT	Total VMT (w/o XX Trips)	Population	VMT / Capita
2022	3,821,174	712,221	87,355	4,533,395	197,020	23.0
S1 (2035)	4,858,924	809,531	108,357	5,668,455	251,863	22.5
S2 (2035)	4,490,299	637,055	108,247	5,127,354	236,433	21.7
S3 (2035)	4,448,439	640,957	108,247	5,089,395	236,433	21.5
S4 (2035)	4,406,984	579,761	108,255	4,986,745	236,433	21.1
2045	4,517,758	591,891	124,833	5,109,649	243,499	21.0

Butte County VMT Summary by Speed Bin

Speed Bin	2022	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)	2045
0-5	2,625	4,022	8,723	5,552	4,597	4,585
5-10	9,105	9,594	11,927	11,188	11,106	11,092
10-15	6,637	15,314	4,247	5,373	5,512	6,472
15-20	12,523	37,200	23,066	20,586	17,223	13,032
20-25	465,792	605,524	538,648	521,415	507,905	521,642
25-30	138,768	190,784	157,763	146,038	152,083	152,428
30-35	979,212	1,166,981	1,095,469	1,075,225	1,057,176	1,073,875
35-40	151,403	249,154	210,853	176,041	167,668	168,033
40-45	675,368	869,883	763,547	732,533	726,985	763,081
45-50	111,635	144,580	150,435	126,494	123,891	146,495
50-55	377,552	595,722	493,107	533,598	520,459	531,924
55-60	143,649	200,627	143,696	168,985	181,289	185,932
60-65	1,546,482	1,687,428	1,634,120	1,674,615	1,619,106	1,655,891
65-70	0	0	0	0	0	0
70-75	0	0	0	0	0	0
>75	0	0	0	0	0	0
VMT (w/o XX Trips)	4,533,395	5,668,455	5,127,354	5,089,395	4,986,745	5,109,649
XX VMT	87,355	108,357	108,247	108,247	108,255	124,833
VMT (w/ XX Trips)	4,620,750	5,776,812	5,235,602	5,197,643	5,095,000	5,234,482
% XX VMT	1.9%	1.9%	2.1%	2.1%	2.1%	2.4%
IX-XI VMT	712,221	809,531	637,055	640,957	579,761	591,891
Population	197,020	251,863	236,433	236,433	236,433	243,499
VMT per Capita	3.6	3.2	2.7	2.7	2.5	2.4

ATTACHMENT I

2024 RTP/SCS Scenarios Summary

See Next Page

2024 RTP/SCS Scenarios Summary

Strategy	Scenario #1 2020 RTP/SCS (No Project)	Scenario #2 2020 RTP/SCS Update	Scenario #3 Latest Trends & Transit Oriented Development	Scenario #4 Latest Trends & Transit Oriented Development +
Land Use				
Growth Areas	New Housing / Jobs	New Housing / Jobs	New Housing / Jobs	New Housing / Jobs
Center	6% / 26%	6% / 26%	20% / 31%	20% / 31%
Established	56% / 60%	56% / 60%	60% / 58%	66% / 59%
New	30% / 11%	30% / 11%	17% / 9%	11% / 8%
Rural	6% / 3%	6% / 3%	2% / 2%	2% / 2%
Ag	2% / 1%	2% / 1%	1% / 1%	1% / 1%
Housing Type	New SF / MF	New SF / MF	New SF / MF	New SF / MF
Housing Mix	68% / 32%	68% / 32%	61% / 39%	58% / 42%
Regional Growth	2020 RTP/SCS	2022-2045 Regional Growth Forecasts	Same as Scenario #2	Same as Scenario #2
Transportation				
Roads	2020 RTP/SCS	2020 RTP/SCS	Updated Project List	Updated Project Delivery Timelines
Transit	2020 RTP/SCS	B-Line Routing Study Implementation	Same as Scenario #2	Increased Transit Frequency
Bike & Pedestrian	2020 RTP/SCS	2020 RTP/SCS	Updated Project List	Increased Bike Facility Miles
Additional	Telecommuting	Telecommuting	Telecommuting	Telecommuting
	Telemedicine	Telemedicine	Telemedicine	Telemedicine
				Workplace EV Charger Incentives
				E-Bike Purchase Incentives
GHG Per Capita Reduction (SB 375)*	-0.35%	-3.58%	-4.44%	-6.59%

*Note - GHG reductions are preliminary until final technical methodology is approved by the California Air Resources Board

9/12/2024

ATTACHMENT J

2024 RTP/SCS Preferred Scenario Draft Results

See Next Page

Modeling Parameters	Category	2005	2022 (Base Year)	2035 Preferred Scenario	2045 (Plan Horizon Year)	Data Source
Modeled Population [1]	Socioeconomic and Demographic Data	208,322	197,020	236,433	243,499	Travel Demand Model input
Vehicle Operating Costs ($/mile)	Socioeconomic and Demographic Data	not available	0.214	0.189	0.183	Travel Demand Model input
Average Toll Price ($/mile)	Socioeconomic and Demographic Data	not available	not available	not available	not available	
Average Median Household Income ($/year) [2]	Socioeconomic and Demographic Data	not available	$50,661	$50,146	$50,190	Travel Demand Model input
Total Number of Households [1]	Socioeconomic and Demographic Data	85,478	84,157	101,118	104,131	Travel Demand Model input
Total Number of Jobs [3]	Socioeconomic and Demographic Data	73,400	77,000	92,400	92,887	Travel Demand Model input
Total Developed Acres [4]	Land Use Data	not available	68,659	76,022	77,339	BCAG Land Use Allocation Model
Total Housing Units	Land Use Data	91,668	91,549	110,000	113,277	BCAG Land Use Allocation Model
Total Single-Family Housing Units (du)	Land Use Data	69,779	64,363	75,146	76,938	BCAG Land Use Allocation Model
Total Multi-Family Housing Units (du)	Land Use Data	21,889	27,187	34,854	36,339	BCAG Land Use Allocation Model
Net Residential Density (dwelling units/acre) Regional Total	Land Use Data	not available	1.33	1.45	1.46	BCAG Land Use Allocation Model
Net Residential Density (dwelling units/acre) Urban Center and Corridor	Land Use Data	not available	3.03	3.73	3.88	BCAG Land Use Allocation Model
Net Residential Density (dwelling units/acre) Established	Land Use Data	not available	2.08	2.19	2.19	BCAG Land Use Allocation Model
Net Residential Density (dwelling units/acre) New	Land Use Data	not available	0.48	1.30	1.36	BCAG Land Use Allocation Model
Net Residential Density (dwelling units/acre) Rural	Land Use Data	not available	0.48	0.47	0.48	BCAG Land Use Allocation Model
Net Residential Density (dwelling units/acre) Agricultural, Grazing, and Forestry	Land Use Data	not available	0.36	0.35	0.35	BCAG Land Use Allocation Model
Households Within ½ Mile of a High-Quality Transit Station or Corridor [5]	Land Use Data	not available	0%	24%	24%	BCAG Land Use Allocation Model
Jobs Within ½ Mile of a High-Quality Transit Station or Corridor [5]	Land Use Data	not available	0%	37%	37%	BCAG Land Use Allocation Model
Freeway and General Purpose Lanes - Mixed Flow, auxiliary, etc. (lane miles)	Transportation Network Data	not available	88	88	88	Travel Demand Model input
Freeway Tolled Lanes (lane miles)	Transportation Network Data	not available	0	0	0	Travel Demand Model input
Freeway HOV Lanes (lane miles)	Transportation Network Data	not available	0	0	0	Travel Demand Model input
Arterial/Expressway (lane miles)	Transportation Network Data	not available	763	772	780	Travel Demand Model input
Collector (lane miles)	Transportation Network Data	not available	872	878	880	Travel Demand Model input
Average Transit Headway (minutes)	Transportation Network Data	not available	55.8	35.9	35.9	Travel Demand Model input
Annual Transit Vehicle Revenue Miles	Transportation Network Data	not available	986,322	1,494,883	1,494,883	Travel Demand Model input
Annual Transit Vehicle Revenue Hours	Transportation Network Data	not available	66,064	100,128	100,128	Travel Demand Model input
Bike and Pedestrian Lane (Class I, II, & IV) Miles	Transportation Network Data	not available	109	197	201	Travel Demand Model input
Household Vehicle Ownership	Plan Performance Indicators	not available	1.7	1.58	1.58	Travel Demand Model output
Average Auto Trip Length (miles)[6]	Plan Performance Indicators	not available	7.13	7.24	7.29	Travel Demand Model output
Average Auto Travel Time (minutes)[6]	Plan Performance Indicators	not available	10.47	10.54	10.59	Travel Demand Model output
Percent Passenger Travel Model Share	Mode Share (%)					Travel Demand Model output
Auto	Mode Share (%)	not available	91.66%	87.63%	87.36%	Travel Demand Model output
SOV	Mode Share (%)	not available	48.26%	44.97%	44.78%	Travel Demand Model output
HOV	Mode Share (%)	not available	43.40%	42.66%	42.58%	Travel Demand Model output
All Other (transit & non-motorized)	Mode Share (%)	not available	8.34%	12.37%	12.64%	Travel Demand Model output
Public Transit (Fixed Route Bus)	Mode Share (%)	not available	1.71%	4.71%	4.85%	Travel Demand Model output
Non-Motorized (Bike and Walk)	Mode Share (%)	not available	6.35%	7.38%	7.51%	Travel Demand Model output
Other (i.e. School Bus)	Mode Share (%)	not available	0.27%	0.28%	0.28%	Travel Demand Model output
Transit Ridership (daily trips) [7]	Mode Share (%)	not available	3,513	11,127	11,694	Travel Demand Model output

Total VMT per weekday (all vehicle class) (miles) [8]	VMT Data	4,728	4,621	5,095	5,234	Travel Demand Model output
Total SB375 VMT per weekday for passenger vehicles (CARB vehicle classes LDA, LDT1, LDT2, and MDV)	VMT Data	3,982	3,858	4,350	4,468	Travel Demand Model output
Total II + IX/XI VMT per weekday (all vehicle classes) (miles)	VMT Data	4,573	4,533	4,987	5,110	Travel Demand Model output
Total XX VMT per weekday (all vehicle classes) (miles)	VMT Data	155	87	108	125	Travel Demand Model output
SB 375 VMT per capita	VMT Data	19.11	19.58	18.40	18.35	Calculated: SB375 VMT / population
Total CO_2 emissions per weekday (all vehicle class) (tons/day) [9]	GHG Emissions Data	2,281	2,401	2,012	1,988	EMFAC model output
Total SB375 CO_2 emissions per weekday for passenger vehicles (CARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons/day)	GHG Emissions Data	1,921	1,772	1,941	1,989	EMFAC model output
Total II + IX/XI CO_2 emissions per weekday (all vehicles) (tons/day)	GHG Emissions Data	2,207	2,356	1,969	1,940	EMFAC model output
Total XX CO_2 emissions per weekday (all vehicles) (tons/day)	GHG Emissions Data	75	45	43	47	EMFAC model output
SB 375 CO_2 per capita (lbs./day)	GHG Emissions Data	18.45	17.99	16.42	16.34	Calculated: (II + IX/XI CO_2) / population / 2000 lbs./ton
SB 375 CO_2 per capita reduction from 2005 (on-model)		not available	-2.48%	-10.99%	-11.43%	Calculated
EMFAC Adjustment Factor [10]	GHG Emissions Data	not available	3.81%	4.81%	not available	CARB Methodology for Estimating CO_2 Adjustment
RTP/SCS Off-Model Adjustment #1 - Long-Term Induced VMT	Off-Model CO2 Emissions Reductions (%)	not available	not available	0.03%	not available	Off-Model Calculation
RTP/SCS Off-Model Adjustment #2 - Telecommute (Exogenous)	Off-Model CO2 Emissions Reductions (%)	not available	not available	-0.33%	not available	Off-Model Calculation
RTP/SCS Off-Model Adjustment #3 - Telemedicine (Exogenous)	Off-Model CO2 Emissions Reductions (%)	not available	not available	-0.01%	not available	Off-Model Calculation
RTP/SCS Off-Model Adjustment #4 - Workplace EV Charger Incentive Program (Strategy)	Off-Model CO2 Emissions Reductions (%)	not available	not available	-0.09%	not available	Off-Model Calculation
RTP/SCS Off-Model Adjustment #5 - E-Bike Incentive Program (Strategy)	Off-Model CO2 Emissions Reductions (%)	not available	not available	-0.02%	not available	Off-Model Calculation
SB 375 CO_2 per capita reduction from 2005 (total)	GHG Emissions Data	not available	**1.33%**	**-6.59%**	**-11.43%**	Calculated

Notes:

[1] 2005: State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010. 2022: State of California, Department of

[2] Average based on aggregate households by income range by TAZ not individual households

[3] 2005 and 2022 data sources: California Employment Development Department, Industry Employment & Labor Force - by Annual Average, March 2021 Benchmark, for Butte County (Chico MSA)

[4] Calculation based on dwelling units an acre (residential) and floor area ratio (non-residential) for each unit allocated by model classification by year.

[5] Calculation of jobs and housing units using land use allocation model and GIS to capture those units/jobs. High quality transit stations and corridors have been identified in BCAG's *2021 Transit and Non-Motorized Plan, B-Line Routing Study* ,

[6] Compared to the base year 2022, the years 2035 and 2045 show a shift from auto modes to active transportation modes, including an increase in the share of transit trips, as well as bike and walk trips. However, the auto trips being shifted are

[7] Transit Ridership based on total person trips by purpose multiplied by transit mode share by purpose

[8] IX-XI VMT and CO2 were "split" at MPO boundary, per agreement with SACOG.

[9] CO_2 emissions were prepared in EMFAC 2014 for the II + IX/XI row only. Total and XX rows are estimated based on the ratio of VMT to CO_2 for each analysis year

[10] 2022 EMFAC Adjustment Factor based on year 2020