Review of Travel Demand Models for Caltrans Projects Analysis

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Table of Contents

List of Figures

List of Tables

Executive Summary

This report evaluates the suitability of regional Travel Demand Models (TDMs) for Caltrans project-level analyses. Regional TDMs in California are largely developed and maintained by Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs). These TDMs are essential for the long-range planning and air quality conformity needs of regional agencies, but they often have limitations for project-level applications. To formalize and understand these limitations, a selection of regional TDMs were reviewed to evaluate their suitability and reasonableness as part of the Caltrans project development process. The Caltrans process involves developing peak hour/period traffic volume forecasts for design purposes, plus daily traffic volumes and vehicle miles of travel (VMT) forecasts to support California Environmental Quality Act (CEQA) compliance.

REGULATIONS AND GUIDELINES

A review of federal, state, and agency-level regulations and guidance revealed:

- Federal law requires the use of network-based TDMs for regional planning and air quality conformity but does not mandate project-level modeling standards. A network-based TDM is commonly a three- or four-step trip-based TDM.
- California's Senate Bill (SB) 375 requires the use of TDMs for regional greenhouse gas (GHG) forecasting. Technical guidance on related model development is provided in the *2024 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations*, California Transportation Commission (CTC), 2024 and the *2024 Regional Transportation Plan Guidelines for Regional Transportation Planning Agencies*, CTC, 2024.
- The CEQA Statute, Guidelines, and published court decisions do not include specific technical guidance related to developing travel demand forecasts, but they do establish expectations for technical adequacy based on substantial evidence and the use of best efforts by lead agencies. While 'best efforts' is subjective, common practice is to follow technical guidance published by applicable federal and state agencies (e.g., Federal Highway Administration, Caltrans, etc.), academic sources like the Transportation Research Board (TRB), and professional societies like the Institute of Transportation Engineers (ITE).

Caltrans has developed formal technical guidance for forecasting related to compliance with CEQA that considers the information above. This includes the *Transportation Analysis Framework (TAF), First Edition,* Caltrans, 2020 and the Transportation Analysis Under CEQA (TAC), First Edition, 2020.[1]

SURVEY AND INTERVIEW

A statewide survey and follow-up interviews were conducted with California's MPOs and RTPAs to assess the use, management, and limitations of regional TDMs. The survey, completed by 25 agencies across urban, suburban, and rural regions, revealed that 68% maintain active regional TDMs. Most models are not designed or fully validated for detailed project-level analyses. Agencies

[1] Caltrans has also developed second editions of these documents that are currently in draft review format.

expressed concerns about forecasting peak hour traffic, induced VMT, transit, and rural travel. Overall, agencies seek stronger guidance and coordination from Caltrans to improve project-level modeling practices and address evolving travel patterns, emphasizing the need for better validation, documentation, and flexible scenario development.

MODEL REVIEW

A more detailed review of four major Activity-based models (ABMs) and two major Trip-based models in California was completed using a structured checklist. The review focused on each model's structure, capabilities, and limitations relevant to project applications, using a structured checklist of assessment criteria based on technical guidance sources noted above. Major findings include:

- All models provide basic documentation but model transparency and user guidance around how to apply the models are limited.
- Model base years are not within the last five years and do not reflect post-COVID conditions.
- Most models lack recent calibration and comprehensive dynamic validation. ABMs do not include land use sensitivity tests. Transit validation is insufficiently detailed at route or station level.
- Sensitivity to recent travel behavior changes, including post-COVID trends, is limited.
- Induced travel effects, especially long-term effects, are not incorporated.
- Models do not include dynamic traffic assignments or time-of-day travel shifts.
- Tolling effects assume full driver response, likely overestimating demand.
- Sub-modules for freight, visitor, and external travel demand are often incomplete or underdeveloped.
- ABMs offer richer detail for regional policy questions but introduce complexity, stochastic variability, and long runtimes that complicate their use for project-level forecasting. Their use often requires technical expertise and significant post-processing, limiting practical application.

PROJECT APPLICATION REVIEW

Review of TDM applications was conducted for four recent Caltrans projects across diverse regions and project types, including managed lanes, freeway widening, and interchange modifications. Major findings include:

- Project documentation lacks transparency about the source model and any modifications or assumptions made for the project level application.
- Analysis years used often mismatch model base and forecast years, with limited explanation or adjustment methods.
- Source models are rarely validated for peak-hour volumes or key transit routes which is directly necessary for project purpose and need.
- Random variation ("noise") in ABMs is seldom tested or accounted for, risking unreliable forecasts of design volumes, CEQA impact findings, and CEQA mitigation effectiveness.

RECOMMENDATIONS

Regional TDMs were developed for long-range planning, not project-level analysis. Caltrans has not consistently explored alternatives, and many MPOs lack resources to adapt their models beyond their limited regional requirements. Key recommendations for aligning models with project needs include:

- Implement a model suitability checklist to evaluate whether regional TDMs can reliably support project-level tasks, including induced VMT analysis.
- Coordinate with MPOs, RTPAs, and CARB to adapt existing models or identify where alternatives are needed.
- Encourage improved model documentation, transparency, and validation for peak and project-level metrics.
- Develop simplified or stand-alone Caltrans models where needed, especially in high-growth areas.
- Update RTP guidelines to include technical standards and support for project-level modeling.
- Develop standardized modeling guidelines for Caltrans project applications, in collaboration with MPOs and RTPAs.
- Support agency capacity-building through training, technical assistance, and potentially rethinking the level of model complexity to align with available resources and project needs.

Introduction

1.1 Purpose

Regional travel demand models (TDMs) play a key role in transportation project decision-making because they produce the traffic forecasts used to size facilities and identify potential environmental impacts. In California, these models are typically developed by metropolitan planning organizations (MPOs), regional transportation planning agencies (RTPAs), or congestion management agencies (CMAs). As required by federal planning requirements, they are built and maintained by organizations to shape long- and medium-term regional plans. In that case, they provide forecast outcomes based on multiple projects and a future land use scenario for key federal processes like development of the regional transportation plan (RTP) and air quality conformity analysis. State requirements under Senate Bill (SB) 375 expanded the expectations for models so they could forecast the greenhouse gas (GHG) effects of Sustainable Communities Strategies (SCS). In addition to regulatory compliance, models help MPOs test policies and investments to improve accessibility, mobility, and promote equity.

Regional TDMs are also applied to forecast project-level outcomes; these results can be quite different from program-level evaluation required for regional applications. Project level outcomes include Caltrans corridor and interchange projects, local agency general or specific plans, and a variety of other individual land use or transportation projects typically analyzed at a local scale. The purpose of this document is to review the regional TDMs used for, or likely to be used for, analysis of Caltrans transportation projects to determine their suitability and reasonableness. The analysis considers multiple uses of the models including the development of design forecasts, environmental impact forecasts, and project benefit assessments.

1.2 Organization of Document

This document is structured into five chapters. Chapter 1 outlines the regulatory context that shapes how regional TDMs are developed and applied, including expectations for California Environmental Quality Act (CEQA) compliance and Caltrans design requirements. Specific expectations are identified from technical guidance related to transparency, validation, and integration with environmental documentation.

Chapters 2, 3, and 4 describe the methodology used to review and understand regional TDM development and use in California, along with key findings. Chapter 2 outlines the design and implementation of a statewide survey and follow-up interviews conducted with MPOs and RTPAs. This chapter also presents results and insights from those engagement efforts. Chapter 3 details the methodology and criteria used to conduct in-depth reviews of six TDMs, focusing on documentation, input data, validation practices, and behavioral sensitivity. Chapter 4 assesses how models are currently being used in Caltrans project-level analyses, highlighting issues such as transparency, mismatched analysis years, and approaches to induced vehicle miles traveled (VMT) forecasting. Finally, Chapter 5 synthesizes insights from the survey, interviews, and model reviews, and offers recommendations to improve the consistency, transparency, and effectiveness of regional models used to support Caltrans projects. The appendices include supporting materials.

1 Regulations and Guidelines

This section discusses the regulations governing the development of regional TDMs and regulatory requirements for project-level applications. In general, TDM regulatory requirements fall on MPOs, related to their role(s) in developing RTPs and complying with air quality conformity requirements under the Clean Air Act (CAA). At the state level, SB 375 created additional expectations related to modeling of regional GHG emissions but most of those expectations are contained in technical guidance recommendations versus statutory language.

For project-level analysis, CEQA has expectations related to general technical adequacy, but no specific statutes or CEQA Guidelines sections apply to travel demand forecasting. Similarly, the National Environmental Policy Act (NEPA) is silent on statutory requirements related to modeling. Technical guidance concerning state of the practice expectations for project-level forecasting applications is summarized below. This information may be used when evaluating project-level forecasts for adequacy as part of CEQA or NEPA legal challenges, so it has a regulatory role to play. As such, a wide range of professional judgement is often used in applying TDMs for project-level analysis.

1.3 Requirements for TDMs Used for Regional Planning

1.3.1 Federal Requirements for Regional Transportation Plans and Air Quality Conformity

Under 23 U.S.C. § 134 and 49 U.S.C. § 5303, MPOs are federally required to develop a Regional Transportation Plan with a minimum 20-year planning horizon.[2] The RTP must support an integrated, multimodal system and be fiscally constrained. For MPOs in nonattainment or maintenance areas, the RTP must also meet Clean Air Act (42 U.S.C. § 7506(c)) requirements, which mandates transportation conformity—ensuring the plan is consistent with the region's State Implementation Plan (SIP) for air quality.

> "No transportation plan or program may be adopted unless it conforms to the applicable implementation plan…" — *Clean Air Act § 176(c)*

Federal law does not explicitly require all MPOs to use a travel demand model. However, under 40 CFR § 93.122(b)(1), MPOs in areas with serious, severe, or extreme ozone nonattainment (or maintenance) status, or with other specified pollutants, must use TDMs to support regional emissions analysis. that follow established, documented methods in current practice.

> "(b) Regional emissions analysis in serious, severe, and extreme ozone nonattainment areas and serious CO nonattainment areas must meet the requirements of paragraphs (b) (1)

[2] 23 U.S.C. 134 – Metropolitan transportation planning https://www.govinfo.gov/app/details/USCODE-2021-title23/USCODE-2021-title23-chap1-sec134
49 U.S.C. 5303 – Metropolitan transportation planninghttps://www.govinfo.gov/app/details/USCODE-2023-title49/USCODE-2023-title49-subtitleIII-chap53-sec5303

through (3) of this section if their metropolitan planning area contains an urbanized area population over 200,000.

> (1) By January 1, 1997, estimates of regional transportation-related emissions used to support conformity determinations must be made at a minimum using network-based travel models according to procedures and methods that are available and in practice and supported by current and available documentation." — *40 CFR § 93.122(b)(1)*[3]

For these areas, TDMs must be validated using observed traffic counts for a base year no more than 10 years prior to the conformity determination. Model forecasts must be evaluated for reasonableness, compared to historical trends, and documented. They should follow Federal Highway Administration (FHWA)/Federal Transit Administration (FTA) guidance, use the latest planning assumptions, and support emissions analysis using models like Environmental Planning Agency's (EPA) MOVES. Travel times used for trip distribution must reflect actual conditions, including transit where applicable. VMT estimates must be reconciled with Highway Performance Monitoring System (HPMS) data for the validation year, with adjustment factors applied to future projections as needed.

In practice, urban MPOs maintain and use regional travel models to meet conformity and long-range planning needs. MPOs must demonstrate and document adherence to federal TDM requirements each time a RTP or project-level air quality conformity finding is made. FHWA staff, as well as members of the public, have an opportunity to review and comment on the MPO TDM.

FHWA also reviews MPO modeling practices and TDMs as part of quadrennial performance audits. The audits include the overall MPO planning process, and TDMs are usually a small part of the review. Depending on the size and complexity of the MPO, and the number and size of transportation investments being analyzed using the TDMs, the extent of the review varies widely. A small MPO with few major federal investment transportation projects might get very little attention in the TDM audit. A large MPO with CAA non-attainment status, and with large, multimodal projects with significant federal funding, would receive much greater scrutiny in the TDM audit.

1.32 California Transportation Commission

The California Transportation Commission (CTC) publishes guidelines to MPOs preparing RTPs.[4] Chapter 3 of this guidance pertains to "RTP Analysis and Modeling." It is telling that in the CTC guidance, the word "shall" appear 314 times; in Chapter 3, though, it appears only once. The one "shall" does not even refer to MPO TDM practice—it limits the scope of modeling recommendations that might come from the California Interagency Modeling Forum (CIMF). The word "encouraged" appears 18 times in Chapter 3, on the other hand, and applies to every one of the TDM practices described in the chapter. All that said, this reference is the most often cited source of guidance for MPOs when developing and applying TDMs for regional planning. "Planning Practice Examples" on the functionality of TDMs based on four categories of MPO are provided in the chapter. Suggested minimum standards for model validation and sensitivity testing are also included in the chapter. The

[3] Procedures for determining regional transportation-related emissions https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-93/subpart-A/section-93.122

[4] California Transportation Commission, Final 2024 Regional Transportation Plan Guidelines for MPOs, adopted-2024-rtp-guidelines-for-mpos.pdf

California Air Resources Board (CARB) cross-references these encouraged practices in its guidance on technical evaluation of SCSs. The chapter provides no guidance on project-level analysis.

The CTC itself does not review MPOs for their use of the Chapter 3 guidance; but the California Air Resources Board (CARB) uses the Chapter 3 guidance in their reviews of TDMs as part of SB 375 implementation.

1.3 California State Requirements under SB 375

Senate Bill 375 (SB 375, 2008)—the Sustainable Communities and Climate Protection Act—requires California MPOs to incorporate a SCS into their RTPs.[5] The SCS must demonstrate how the region will meet greenhouse gas emission reduction targets from passenger vehicles, as established by the CARB. If the SCS cannot meet GHG targets, the MPO must prepare an Alternative Planning Strategy (APS) to show how targets could be achieved through alternative land use or transportation strategies.

While SB 375 does not explicitly require the use of a travel demand model, it requires the SCS to quantify GHG emission reductions resulting from land use and transportation strategies. Further, it requires CARB to review and approve the technical methodology proposed by each MPO for calculating the SCS GHG reductions. In practice, all MPOs maintain and use TDMs for SCS GHG calculations, and CARB has been rigorous in their TDM reviews. CARB's TDM reviews focus on model functionality, validation, and sensitivity testing. In the event the MPO's TDM does not have functionality to estimate effects of a particular RTP/SCS strategy, CARB allows for the use of off-model calculations and other approaches to estimate the effects of that strategy.[6]

CARB guidance expects MPO to use TDMs that are capable of the following:

(1) Estimating how land use and transportation strategies influence key travel behaviors such as trip generation, mode choice, trip length, and time-of-day travel patterns
(2) Capturing the impact of land use, transit, pricing, and policies on VMT and GHG emissions
(3) Supporting scenario analysis and sensitivity testing
(4) Producing outputs consistent with CARB's Modeling Technical Methodology

The SB 375/CARB review process provides some level of assurance that MPO TDMs meet basic federal requirements and follow state guidance. It has initiated significant state dialog on the adequacy of current TDMs to represent both the supply and demand side of auto operating costs and behavioral response to variations in auto operating costs; facility-based pricing; alternatives to travel (e.g., telework, etc.); and ridesharing and micro-mobility as new modes of travel. CARB's SCS review process has elevated basic sensitivity testing of TDMs. However, effective review of the complex TDMs used by MPOs require well-trained analysts, and CARB competes for those analysts with MPOs and private sector consultants. Hiring, training, and retaining TDM analysts is an ongoing challenge for CARB. The CARB review process does not include use of TDMs for project-level analysis.

[5] Senate Bill 375 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200720080SB375
[6] *CARB, Final Sustainable Communities Strategy Program and Evaluation Guidelines (2019), https://ww2.arb.ca.gov/sites/default/files/2019-11/Final%20SCS%20Program%20and%20Evaluation%20Guidelines%20Report.pdf*

1.4 TDM Requirements for Project-Level Application

1.4.1 CEQA Expectations

CEQA is a state law enacted in 1970 that requires public agencies to identify, disclose, and mitigate environmental impacts of their projects to the extent feasible. CEQA compliance has two basic elements. One, the legal risk of challenge associated with inadequately analyzing impacts due to use of models that do not meet benchmark expectations. Two, the mitigation risk of misidentifying the impact and mitigation strategies to reduce the impact. Agencies and project applicants with a high risk of legal challenges will likely be concerned about both elements while agencies/applicants with less legal risk should still be concerned about the second element since it is also relevant for all other transportation analysis based on model forecasts.

The CEQA Guidelines contain clear expectations for environmental analysis as noted below; however, the Guidelines are silent about what data, analysis methods, models, and mitigation approaches are adequate for transportation modeling and impacts.

CEQA Guidelines - Expectations for Environmental Impact Analysis

> § 15003 (F) = fullest possible protection of the environment…
>
> § 15003 (I) = adequacy, completeness, and good-faith effort at full disclosure…
>
> § 15125 (C) = EIR must demonstrate that the significant environmental impacts of the proposed project were adequately investigated…
>
> § 15144 = an agency must use its best efforts to find out and disclose…
>
> § 15151 = sufficient analysis to allow a decision which intelligently considers environmental consequences.

All these suggest a robust technical approach (including use of 'best efforts') is important and has largely been recognized by the courts as the context for judging an adequate analysis. So, what is the basis for determining a best effort when it comes to forecasting and transportation impact analysis? A review of relevant court cases suggests the following conclusions.

- CEQA does not require the use of any specific methodology. Agencies must have substantial evidence to support their significant conclusions. (Association of Irritated Residents v. County of Madera (2003) 107 Cal.App.4th 1383)
- CEQA does not require a lead agency to conduct every test or perform all research, study, and experimentation recommended or demanded by commenters. (CEQA Guidelines, § 15204, subd. (a))
- CEQA does not require perfection in an EIR but rather adequacy, completeness, and a good-faith effort at full disclosure while including sufficient detail to enable those who did not participate in the EIR preparation to understand and meaningfully consider the issues raised by the project. (Kings County Farm Bureau v. City of Hanford (1990) 221 Cal.App.3d 692)

- Lead agencies should not use scientifically outdated information in assessing the significance of impacts. (Berkeley Keep Jets Over the Bay Comm. v. Board of Port Comm. (2001) 91 Cal.App.4th 1344)
- Impact analysis should improve as more and better data becomes available and as scientific knowledge evolves. (Cleveland National Forest Foundation v. San Diego Association of Governments, Cal. Supreme Ct. S223603, 2017)

These conclusions reinforce the basic tenet of CEQA that requires having substantial evidence to support all aspects of the impact analysis and related decisions. Further, analysis should produce accurate and meaningful results. This expectation is grounded in the basic purpose behind environmental regulations like CEQA that attempt to accurately identify and disclose potential impacts and develop effective mitigation to help intelligently inform the decision-making process. Having accurate and reliable travel forecasts is essential for meeting these expectations.

In setting specific CEQA expectations for travel forecasting models, an important consideration is that expectations may vary based on the variety of factors listed below:

- Complexity of the transportation network and number of operating modes
- Available data
- Urban versus rural setting
- Planned changes in the transportation network (particularly to major roads or transit systems)
- Availability of resources to develop and apply travel demand models
- Population and employment levels
- Congestion levels
- Regulatory requirements
- Types of technical and policy questions posed by decision-makers
- Desired level of confidence in the analysis findings
- Anticipated level of legal scrutiny

In California, travel forecasts are generated using various forms of models ranging from simple spreadsheets based on traffic growth trends to complex computer models that account for numerous factors that influence travel demand. According to *Transportation and Land Development*, 2nd Edition, ITE, 2002, the appropriate model depends on the size of the development project and its ability to affect the surrounding area. Larger, more complex projects often require TDMs due to variables involved and regional implications. However, these models must also be able to accurately represent the project. However, this can be challenging when using "off-the-shelf" models, which are developed for regional planning rather than the specifics of a single project, especially if it is a complex land use project.

The study area's characteristics, such as congestion or the presence of multiple transportation modes, also affect the model choice. For more detailed guidance, the *NCHRP Report 765* (2014)[7] provides additional resources on model applications for project-level planning and design. A few direct excerpts for models are listed below:

[7] *NCHRP Report 765, Analytical Travel Forecasting Approaches for Project-Level Planning and Design* https://nap.nationalacademies.org/read/22366/chapter/1

- *A travel forecasting model should be sensitive to policies and project alternatives that the model is expected to help evaluate.*
- *A travel forecasting model should be capable of satisfying validation standards that are appropriate to the application.*
- *Project-level travel forecasts, to the extent that they follow a conventional travel model, should be validated following the FHWA validation guidelines. This level of validation is necessary, but not sufficient, for project-level forecasts. Project-level forecasts often require better accuracy than can be obtained from a travel model alone.*
- *The model should be subject to frequent recalibrations to ensure validation standards are continuously met.*

1.42 Caltrans Requirements

Travel demand modeling efforts must align with California's regulatory framework, particularly in evaluating transportation impacts under CEQA and SB 743. VMT has replaced traditional metrics like level of service (LOS) as the primary measure of environmental transportation impacts. Models must be capable of assessing how proposed projects affect VMT, consistent with federal requirements and guidance from the state. These models must also produce reasonable traffic volume forecasts that influence the design of transportation projects and other environmental impact subjects like noise.

Caltrans provides two documents for districts to use in analyzing transportation projects: Transportation Analysis Under CEQA[8] (TAC) and Transportation Analysis Framework[9] (TAF). Combined, the documents provide guidance on analyzing induced VMT generated by a transportation project on the state highway system. The TAC focuses on project scoping, determining if a project is likely to generate induced VMT, and determining if the VMT induced constitutes a significant impact. The TAF focuses on available approaches to forecasting the amount of VMT induced by a project. If the TDM meets certain conditions stated in the TAF adequacy checklist (Table 4), it can be used to forecast induced VMT. One set of conditions relates to land use forecasts used in the TDM:

(1) 1a: Is the model's specification of future land use sensitive to travel time and cost, i.e., varying across modeling scenarios to simulate the land use response to network changes? or
(2) 1b: If future year land use is exogenous to the modeling process, are land use assumptions determined via a Delphi method or through examination of outcomes under a range of modeling scenarios, including both build and no build alternatives?

Complying with condition 1a would likely require a multi-year effort by an MPO since it involves the development, calibration, and validation of a new model system that is sensitive to project-scale applications. MPOs that use spatial-economic modeling, integrated with the TDM, only do so for regional transportation analysis (more on this topic in the interview section, below). Condition 1b

[8] Caltrans' Transportation Analysis Under CEQA (TAC) First Edition: Evaluating Transportation Impacts of State Highway System Projects, September 2020.
https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-09-10-1st-edition-tac-fnl-a11y.pdf

[9] Transportation Analysis Framework (TAF) First Edition: Evaluating Transportation Impacts of State Highway System Projects, Caltrans, September2020.
https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/sb-743/2020-09-10-1st-edition-taf-fnl-a11y.pdf

could be used in the short term, but finding practitioners with the economic, land development, and transportation knowledge to participate in a Delphi process like this would has been very limited to date. No MPO we interviewed said they could meet either 1a or 1b.

A second set of TAF checklist conditions (2a, 2b, 2c) relates to the level of TDM sophistication and detail representing the changes to travel time and cost in various ways (i.e., trip generation, distribution, mode choice, route choice, etc.). Most MPO models could arguably meet these three conditions and demonstrate the required sensitivity through testing. However, as discussed in more detail below, most MPO models have not been subjected to rigorous testing for project-scale sensitivity.

Caltrans has provisionally accepted a "hybrid" approach for using TDMs to forecast induced VMT. The concept is that a TDM that can meet conditions 2a/2b/2c and demonstrate the short-term effects that cause induced VMT are accounted for through testing. An elasticity-based calculator would be used to forecast the long-term effects that cause VMT by deducting the short-term effects from the elasticity-based calculation. No project has used this provisionally accepted approach. A related question raised by the fact that induced VMT effects may differ between short-term and long-term conditions is whether Caltrans environmental impact analysis should rely on baseline plus project conditions to represent 'short-term or project impacts' and design-year plus project conditions to represent 'long-term or cumulative impacts'.

Current Caltrans practice is to treat induced VMT as a singular effect with no difference between baseline and cumulative conditions. The largest travel time reduction occurs from new lanes in the opening year and then dissipate over time as new population and employment growth consume the new lane capacity. The long-term effects do not diminish to zero. Instead they are likely to contribute to a higher level of VMT per capita in the affected area due to the promotion of more car-centric land use patterns. For some contexts, short-term 'baseline plus project' conditions could produce higher induced VMT levels than under long-term cumulative conditions. A TDM could be used forecast the expected short-term induced VMT effects under baseline plus project conditions while the elasticity method could be used to capture the cumulative effect.

The TAC and TAF provide a solid foundation for determining the appropriate approaches to forecast induced VMT effects of transportation projects. In combination, these documents produce a small window of applicability for using regional TDMs. A limiting factor in the usefulness of the TAC and TAF for project level analysis is that it focuses exclusively on induced VMT. Most projects' "purpose-and-need" focuses on other topics (increasing person throughput, improving freeway operations, improving safety, etc.) and TDMs are used by district project teams to analyze those other topics and produce peak hour design volumes. TDMs should be validated for all outputs used to assess the purpose and need objectives in addition to environmental impact metrics.

1.4.3 Other Guidance on Project-Level Analysis

The TAF and TAC do not provide guidance on state of the practice or best practices in using a TDM for a project-level analysis. Other guidance is relevant to this topic:

(1) National Cooperative Highway Research Program (NCHRP) published "Analytical Travel Forecasting Approaches for Project-Level Planning and Design."[10] The stated objective of NCHRP 765 is to "evaluate and describe currently used methods, data sources, and procedures for producing travel forecasts for highway project-level analysis." The report covers many general topics related to project-level analysis (starting with "What is a project?") and includes many references to using a TDM for a project-level analysis. As such, it is an appropriate reference for a practitioner involved in the analysis of a proposed transportation project. The report offers multiple ways of approaching many tasks, and is biased toward description, rather than evaluation or recommendation, of analysis methods.

(2) Though not explicitly a reference for project-level analysis, the FHWA Travel Model Improvement program (TMIP) "Travel Model Validation and Reasonableness Checking Manual"[11] discusses the differing needs for model validation for project-level analysis compared to regional or policy analysis. For example, the manual suggests project-level analysis models should focus on matching more detailed absolute counts on roadway segments, rather than systemwide totals used for policy analysis. The manual also suggests matching time-of-day counts for project-level models, rather than daily counts used for policy analysis. The manual also gives many suggestions for validation metrics that can be adapted for more detailed, project-level models.

[10] NCHRP Report 765, "Analytical Travel Forecasting Approaches for Project-Level Planning and Design", 2014.
[11] Travel Model Improvement Program, "Travel Model Validation and Reasonableness Checking Manual, 2nd Edition", 2010. https://rosap.ntl.bts.gov/view/dot/55924

2. Agency Survey and Interviews

2.1 Survey Objectives and Design

A formal survey was conducted to gain a comprehensive understanding of how TDMs are used and managed by MPOs and RTPAs across California. The Microsoft Forms survey was shared online, allowing respondents to complete it electronically and streamline the collection of responses. **Figure 1** shows a snapshot of the Survey.

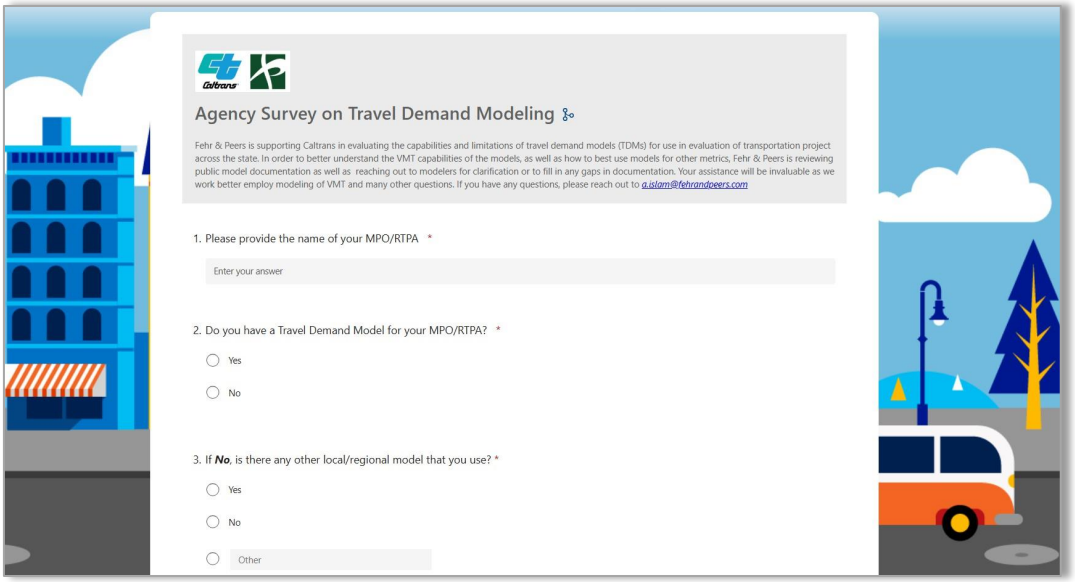
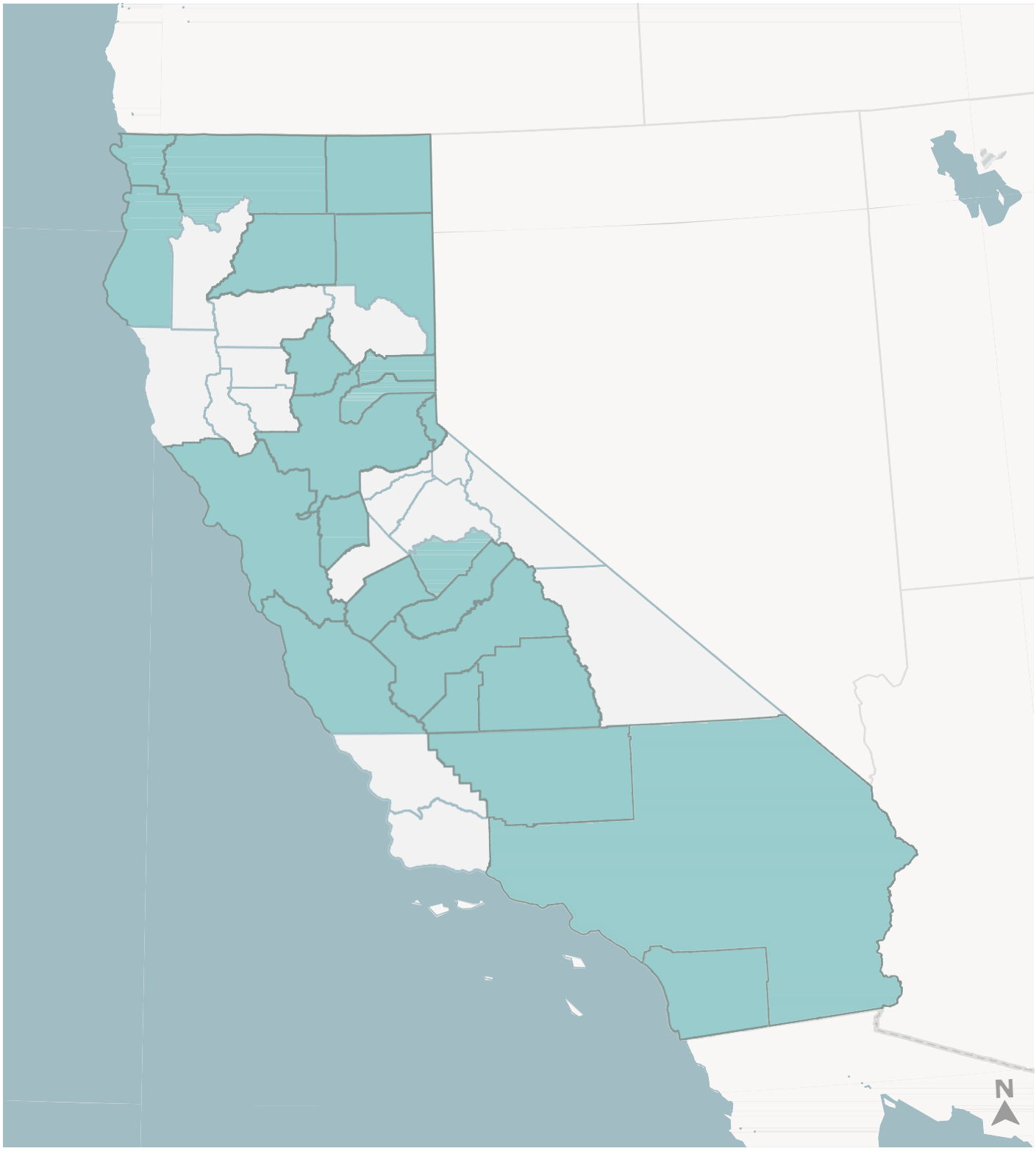


Figure 1: Survey Questionnaire

The survey was distributed to all 44 MPOs and RTPAs in the State of California to capture a diverse range of experiences from both urban and rural regions. It consisted primarily of structured, multiple-choice questions while also providing opportunities for open-ended comments where agencies could elaborate on their practices, challenges, and priorities. By targeting key areas of model use and maintenance, the survey was intended to establish a statewide snapshot of modeling capacity, highlight differences across regions, and identify opportunities for improvement and coordination that would make TDMs more capable of meeting the project-level forecasting needs of Caltrans and other agencies. The survey also aimed to address gaps in publicly available information about the models, their appropriate application, and limitations. **Appendix A** includes the survey and all survey responses.

2.2 Survey Participation

A total of 25 agencies responded to the survey, including 15 MPOs and 10 RTPAs. Caltrans District 1 provided additional input as they manage the models for Del Norte, Humboldt, and Lake-Mendocino planning organizations. This participation represents a diverse cross-section of urban, suburban, and rural regions across the state, providing a broad understanding of current modeling practices. **Figure 2** geographically shows the participating agencies.



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Survey Responded

No

Yes

Figure 2

Agencies Surveyed

2.3 Key Findings from Survey Responses

2.3.1 TDM Availability

TDMs are essential tools for regional agencies to support long-range transportation planning and meet state and federal requirements like air quality conformity. In addition to regulatory compliance, models help MPOs test policies, strategies, and investments for improving accessibility and mobility while ensuring they align with regional goals and environmental standards. However, not all agencies have their own models.

Of the agencies that responded, 68% reported an active TDM for their region. Conversely, 32% indicated they do not maintain a model. Only 13% of agencies reported using another local or regional model to supplement their planning efforts. **Figure 3** shows the percentage of agencies that have TDMs.

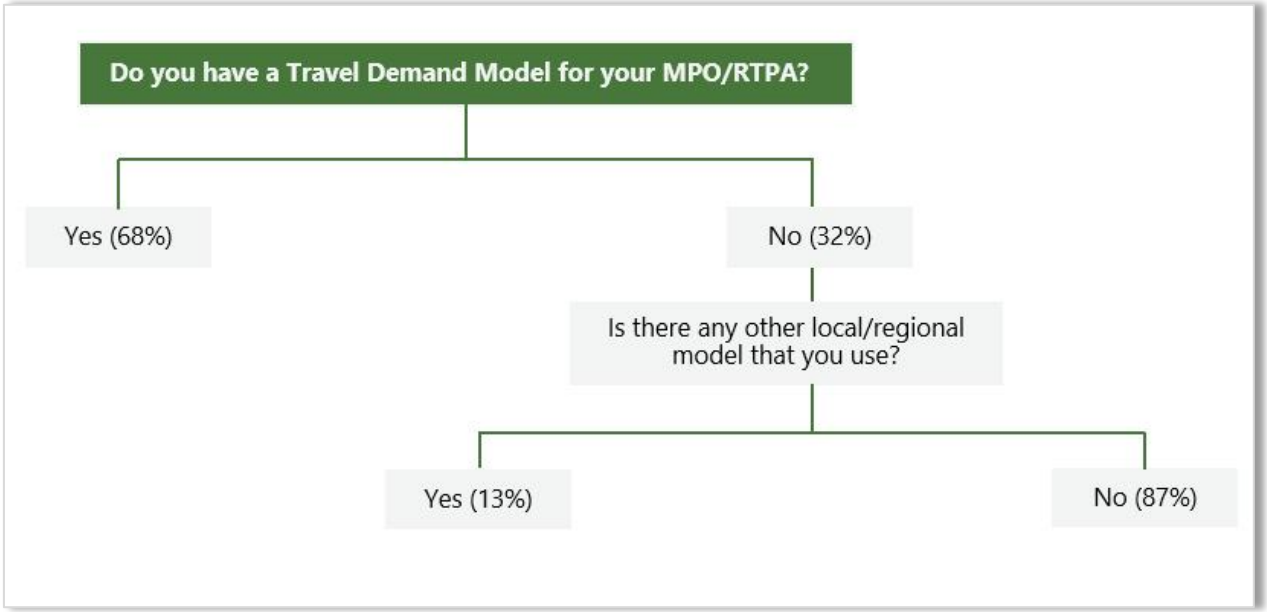

Figure 3: TDM Availability

2.3.2 Legal and Regulatory Requirements

Agencies cited a range of legal and regulatory requirements that guide the development and application of their models. Models are used to support federal laws such as the CAA and state laws such as California's SB 375.

2.3.3 Model Management and File Share

Understanding who manages a TDM and its versions is important to ensure the model is adequately maintained and appropriate versions are applied for specific studies. Clear model management helps maintain up-to-date documentation for understanding how to apply the model and interpret its

inputs and outputs, track changes over time, allow for periodic updates to fix bugs or anomalies, and ensure compliance with software licensing and hardware requirements. Model management also supports transparency and accountability, making it easier to respond to questions from decision-makers, the public, and regulatory agencies. Among survey respondents, 68% of agencies reported that agency staff directly maintain the models, while 16% rely on consultants. The rest reported a shared responsibility between internal staff and external consultants. **Figure 4** shows the survey responses for model management practices.

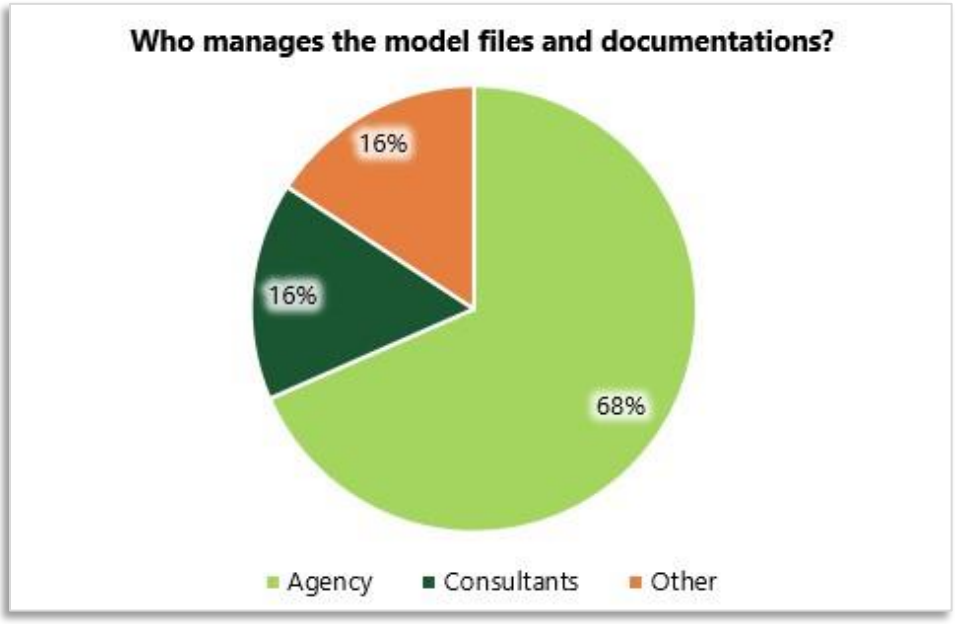

Figure 4: Model Management

A majority of the agencies (84%) indicated they share their models with external entities, such as consultants working on local projects. Full access to all input and output files is provided by 42% of agencies, while 37% limit access to major inputs and outputs only. This is important because without access to all model files, users may have difficulty replicating model results, resulting in inconsistent forecasts. In addition, models that are openly shared with multiple users have more 'eyes on the model looking for and fixing errors or anomalies. 16% of agencies do not share their model files, meaning that they do all modeling in-house and without the benefit of an external user base. **Figure 5** shows the survey responses for model sharing practices.

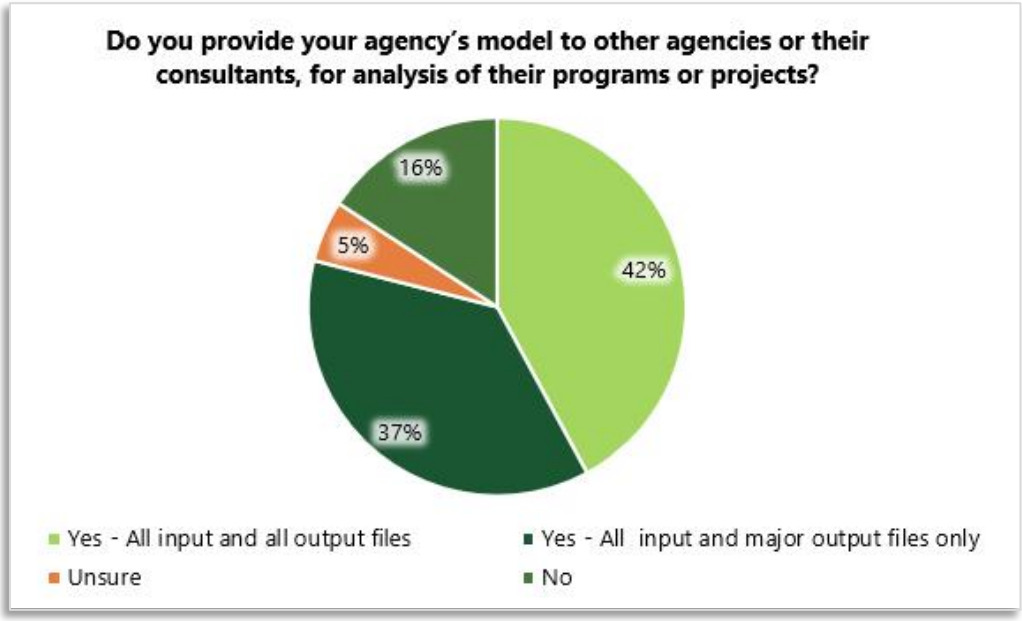

Figure 5: Model Share

2.3.4 Model Documentation

Most agencies make some form of model documentation available, either publicly or upon request. Common resources include Model Development Reports. In some cases, an installation guide is also available. User Guides covering how to appropriately apply the model are rare, especially among larger agencies. Proper model documentation and a user guide are necessary to ensure the model is being applied in the right way.

While almost 85% of the agencies reported that they share a model development report and 75% reported that they share a user manual, upon further investigation, it was found that the level of detail in those documentations varies significantly. Most user manuals simply describe how to install the model. Agencies did not have comprehensive user guides for making edits to the model land use, network, and other parameters. This is especially critical when applying regional models to access local impacts. This is also critical when considering activity-based models (ABMs) which are advanced TDMs that simulate individual travel choices based on a person's daily activities, such as commuting, shopping, and leisure, rather than relying on aggregate trip patterns. ABMs include more complex input data and parameters to accurately represent the interactions between various land uses and the transportation network. Without comprehensive documentation, applying ABMs or regional models to assess local impacts becomes particularly challenging, as the models may not reflect the unique characteristics of the project area. and when **Figure 6** shows the survey responses for various model documentation availability.

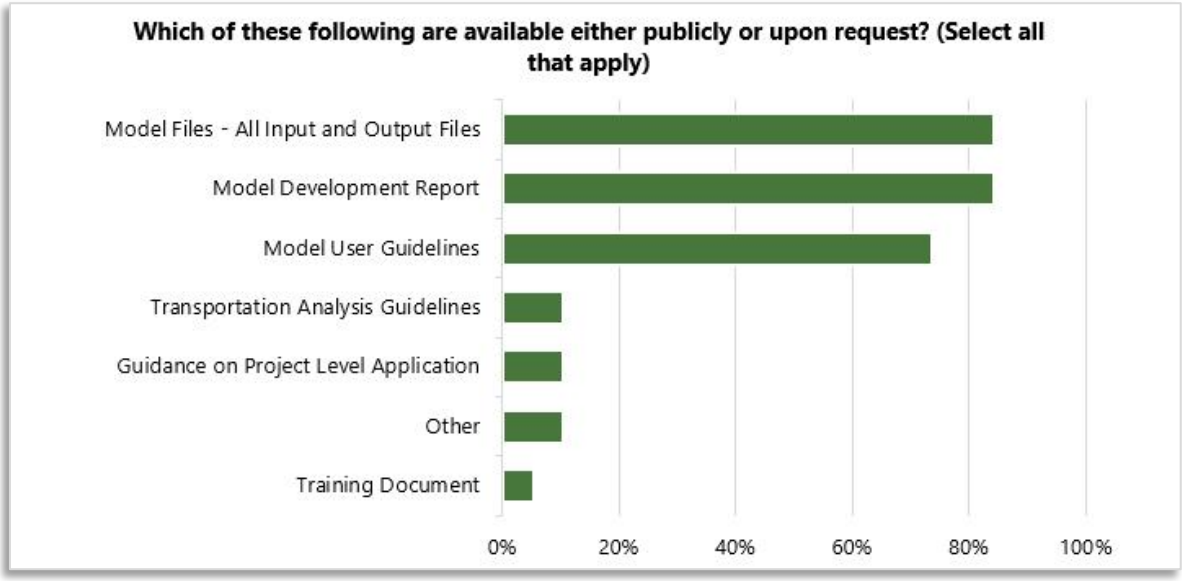

Figure 6: Documentation Availability

2.3.5 Model Applications

TDMs are widely used to support a variety of planning efforts. Regional analyses, such as RTP/SCS, air quality conformity, and Transportation Improvement Programs (TIPs) are the most common applications. About half of the agencies indicated using their models for corridor studies, sub-regional plans, and other transportation project analyses. Only two agencies indicated using their model for the development of impact fee programs. This context is important because regional "off the shelf" models are often unsuitable for localized, project-specific studies as they are designed for regional applications and require significant customization to reflect specific local conditions. If models are being used to analyze impacts at a local level, sub-area validations should be performed. **Figure 7** shows the survey responses for model application priorities for the MPOs.

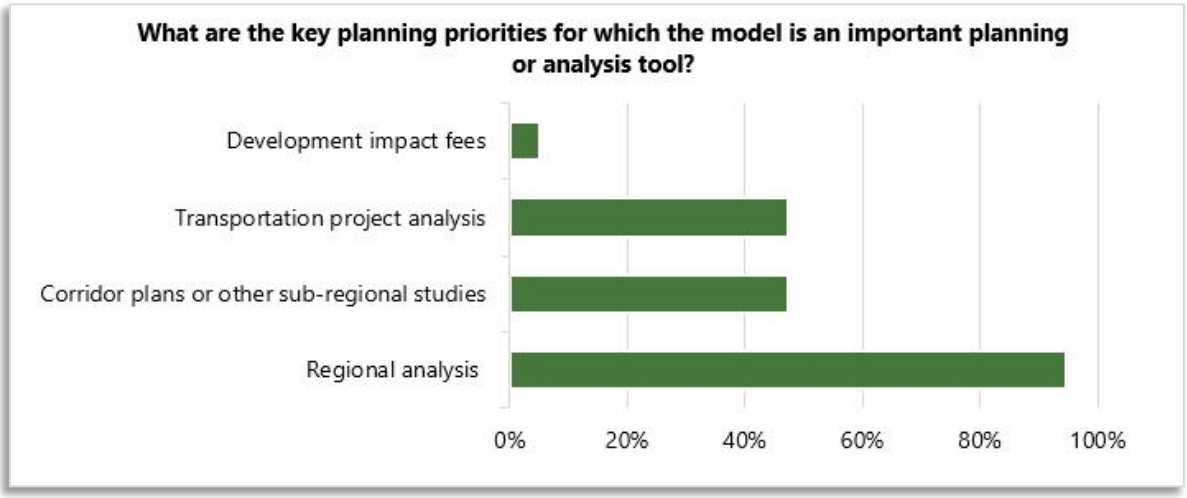

Figure 7: Planning Priorities using TDM

Upon examining the model use guidelines, we found that most models do not provide guidance on sub-area validations and model calibrations to better reflect localized impacts. To understand if the model is suitable for local projects, agencies were asked if they thought the unmodified or "off-the-shelf" models are adequate for use in various project and plan types. Most agencies indicated their models could adequately support analyses related to RTPs and SCS projects. About 70% indicated their model being adequate for analyzing roadway projects, 65% mentioned alternatives evaluation, and about 52% mentioned land use/development projects. However, fewer agencies felt confident applying their models for environmental analysis such as VMT for CEQA impact analysis involving transportation, air quality and noise impacts. When considering more specific projects such as managed lanes, freight, or active-transportation projects, most agencies felt that their "off-the-shelf" model could not adequately assess the impacts. These responses formed part of the basis for evaluating example projects in Chapter 4 of this document, where we reviewed how the model was updated to account for the impacts of Caltrans facilities/managed lane projects. **Figure 8** shows the survey responses for model adequacy for project-level applications.

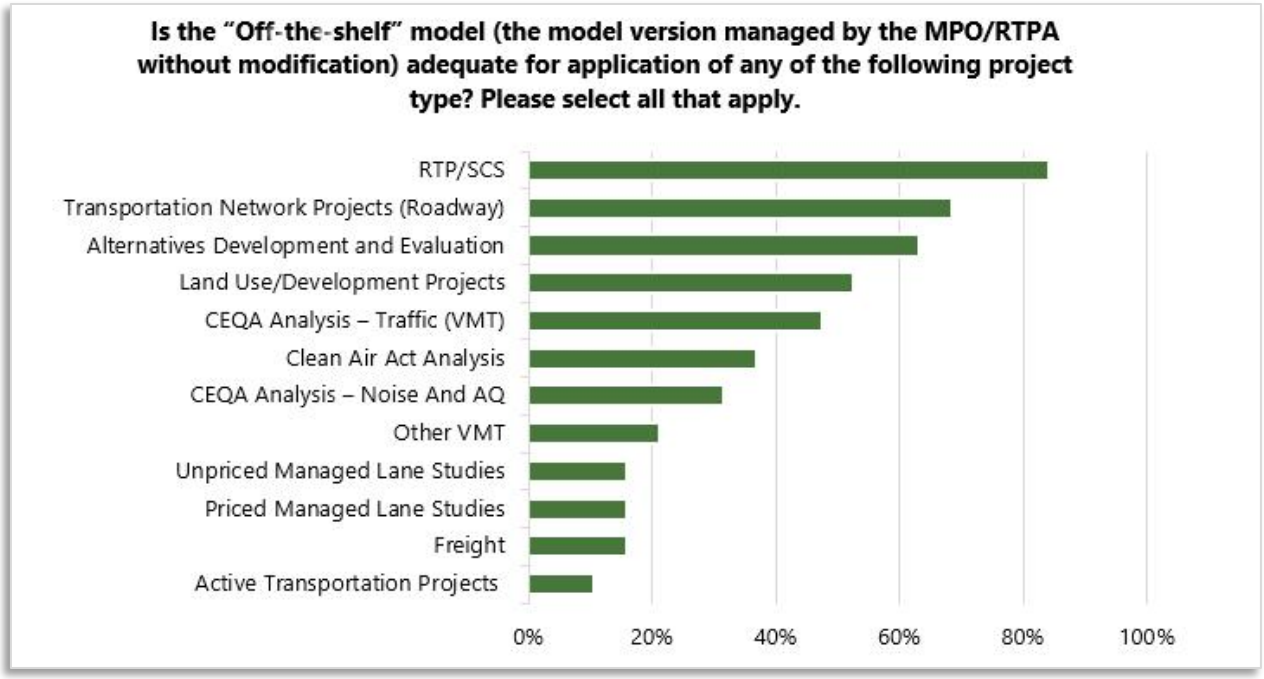

Figure 8: Model adequacy for project-level application

2.6 Model Calibration and Validation

When asked about the last time their models were calibrated and validated, agencies reported a wide range of timelines. About 53% of agencies indicated recent updates within the last two years, 21% reported the last update being three to five years ago, 10% reported six to ten years ago, and 16% of agencies were unsure when the last calibration took place. Upon further investigation and follow-up interviews, we concluded that although most agencies have calibrated and validated their model within the past five years, the base year used for calibration and validation was still pre-pandemic; only about 10% of models have undergone post-pandemic model calibration among the reporting agencies. This is important because travel behavior changed during the pandemic and is not fully

captured in these current model versions. **Figure 9** shows the survey responses for model calibration/validation timeline.

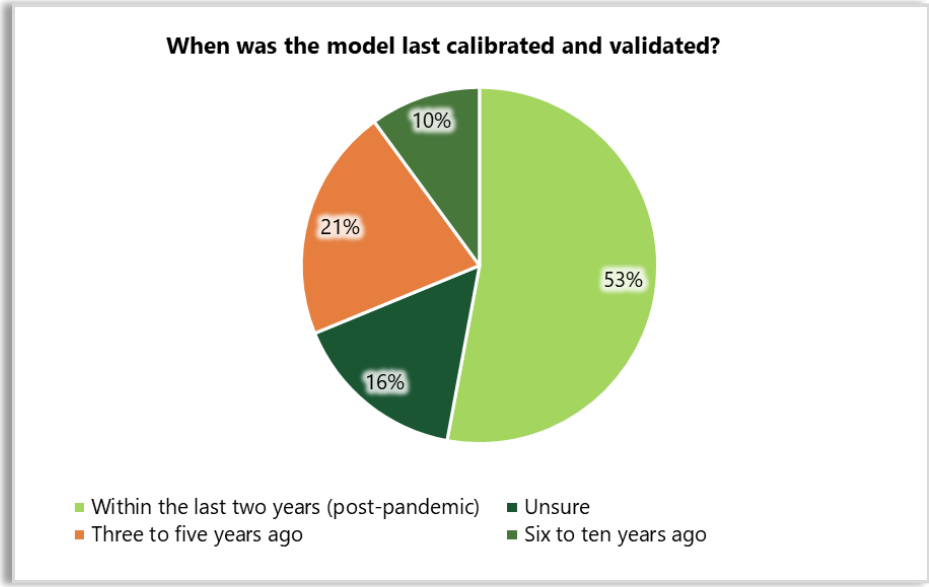

Figure 9: Model calibration/validation timeline

Standard validation metrics include traffic volumes, trip generation, mode share, and VMT. See **Appendix A** for a comprehensive list. **Figure 10** shows the static validation metrics listed in the survey response.

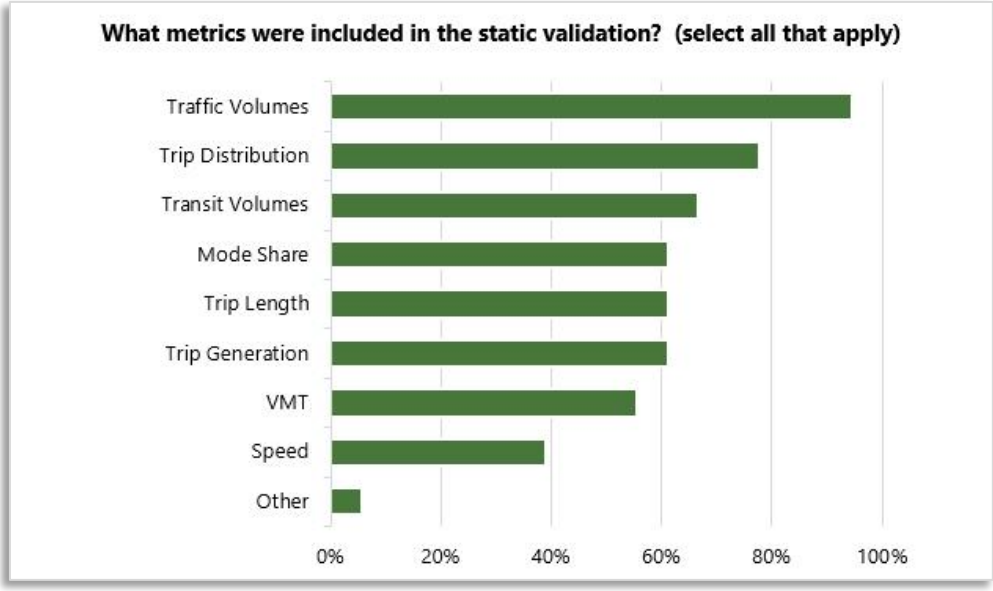

Figure 10: Static Validation Metrics

Dynamic validation or sensitivity testing are techniques used to assess the sensitivity, suitability, and reliability of TDMs. Dynamic validation involves making input variable changes and then measuring

the direction and magnitude of the output variable changes. The output changes are compared to observed data to verify that the model is responding in a suitable manner consistent with real-world performance. This testing helps identify key factors influencing the model's performance and calibration required to ensure reliable forecasts. However, only 63% of respondents indicated that they perform dynamic validation or sensitivity testing as part of their model management practices. **Figure 11** shows the survey responses for dynamic validation practices.

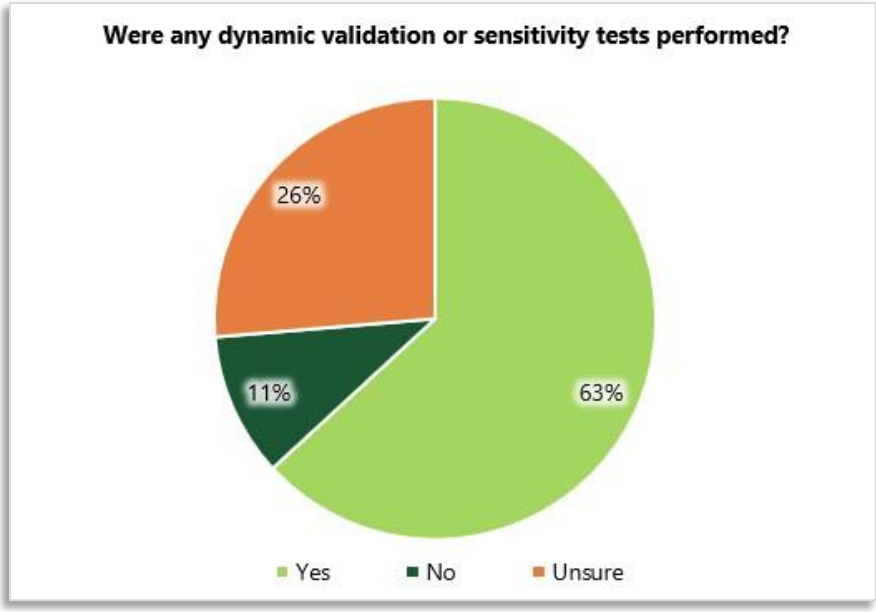

Figure 11: Dynamic Validation Practices

Agencies reported testing model responses to changes in network capacity, land use patterns, transit service levels, pricing strategies, and other policy levers. Common scenarios include adding or removing lanes, adjusting transit frequencies, modifying auto operating costs, and simulating increased telework rates. Reviewing available documentation revealed that few of these tests involved project-scale applications. See **Appendix A** for all listed tests.

2.3.7 Land Use Scenarios

Agencies develop separate land use scenarios to align with different transportation strategies within the RTP/SCS processes. However, most agencies only develop a base year and a cumulative year land use scenario. Only a handful of agencies develop land use scenarios for interim years. The single future year scenario focused on the RTP/SCS has at least two key implications. First, the starting future year scenario for Caltrans project analysis does not have a 'no build' scenario. Most Caltrans projects advancing through the project development and environmental review process involve projects included in the RTP. Hence, the project and its influence on future land use forecasts must be removed from the model to produce a reasonable no build future scenario. Second, the influence of meeting SCS targets has produced future land use scenarios that can deviate from actual growth patterns tied to general plans and CEQA requirements for cumulative conditions to reflect "probable" or "reasonably foreseeable" conditions. **Figure 12** shows the survey response for the land use scenario development practices.

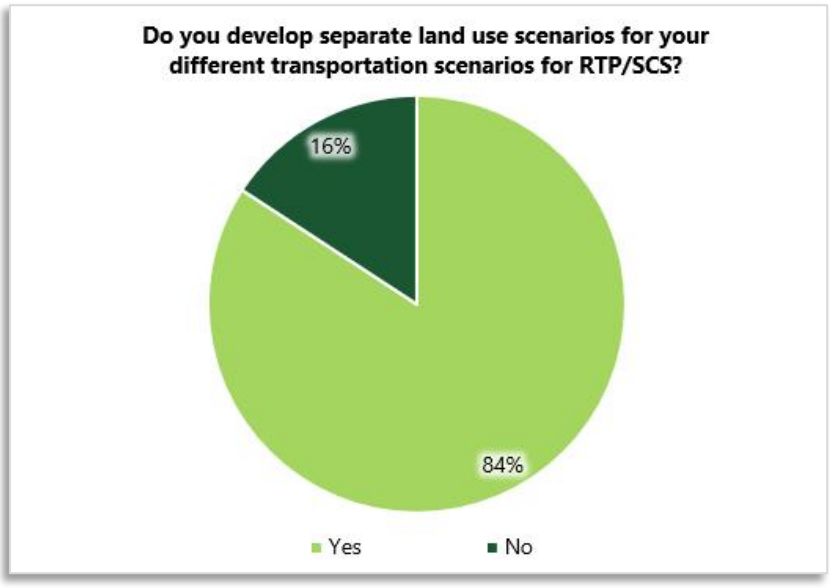

Figure 12: Land use scenario development practices

2.8 Post-Pandemic Adjustments

The COVID-19 pandemic significantly altered travel behavior and traffic patterns. Only 37% of agencies introduced post-pandemic adjustments into their models. Agencies mentioned adjustments for increased work from home, shifts in mode preferences, and updates based on the latest traffic counts.

Notable adjustments include recalibrating the model to reflect year 2022 data, accounting for telework trends from local surveys and ACS data, and partial recalibrations of origin-destination trip patterns to reflect business closures. In contrast, 63% of agencies indicated their models do not yet include any post-pandemic adjustments. **Figure 13** shows the survey responses for post-pandemic model adjustments.

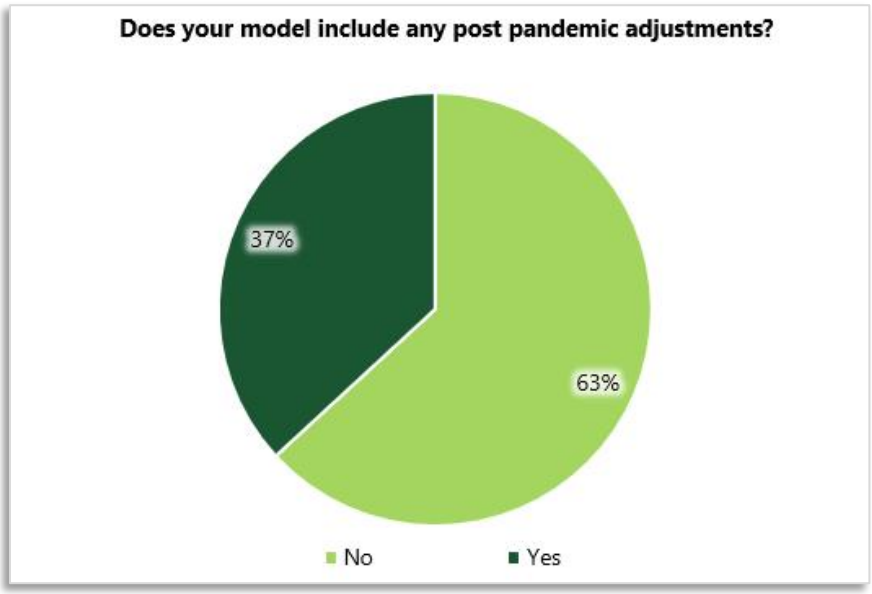

Figure 13: Post-pandemic adjustments

This is important because travel behavior and transportation systems are evolving rapidly in response to emerging technologies, shifting user preferences, and the lasting effects of the COVID-19 pandemic. Trends such as increased online shopping, home delivery, expanded remote work, the growth of shared mobility options, and the development of autonomous vehicles are changing how, when, and why people travel. Further, the distribution of traffic across the day has changed and the conventional design hour (e.g., 30th highest hour) may no longer occur between 5–6 PM. This trend was already in motion before the pandemic and models need to reflect accurate peak hour conditions given how they influence Caltrans project design decisions.[12] The behavioral shifts have already contributed to declines in certain types of trips, such as in-person shopping or commuting by transit, and may lead to increased vehicle miles traveled through behaviors like vehicle repositioning or longer trip-making in autonomous vehicles. Despite these changes, traditional TDMs often do not account for new travel modes or behavioral responses to these trends. As a result, there is a growing need for models to incorporate greater flexibility and scenario-based approaches to better reflect current and future travel patterns shaped by technological, economic, and social change.

2.9 Concerns About Model Suitability

Agencies expressed several concerns about the suitability of their regional models for specific applications, both at the program and project levels. Common limitations cited include the ability to produce reliable peak hour intersection turning movement forecasts, adequately forecast induced VMT, conduct meaningful equity analyses, forecast rural travel behavior, and provide accurate transit forecasts. **Figure 14** shows the survey responses for concerns regarding plan-level model applications and **Figure 15** shows the survey responses for concerns regarding project-level model applications.

[12] https://www.fehrandpeers.com/blog/evolving-standard-validation-practices-for-traffic-data/

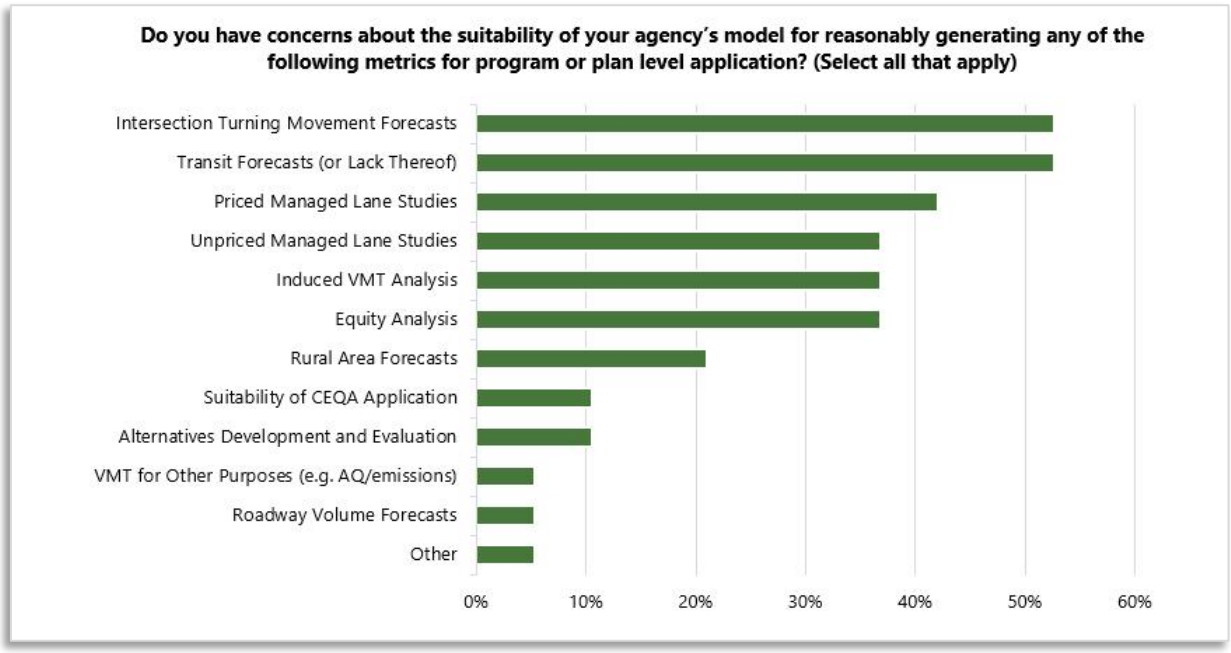

Figure 14: Concerns regarding plan-level model applications

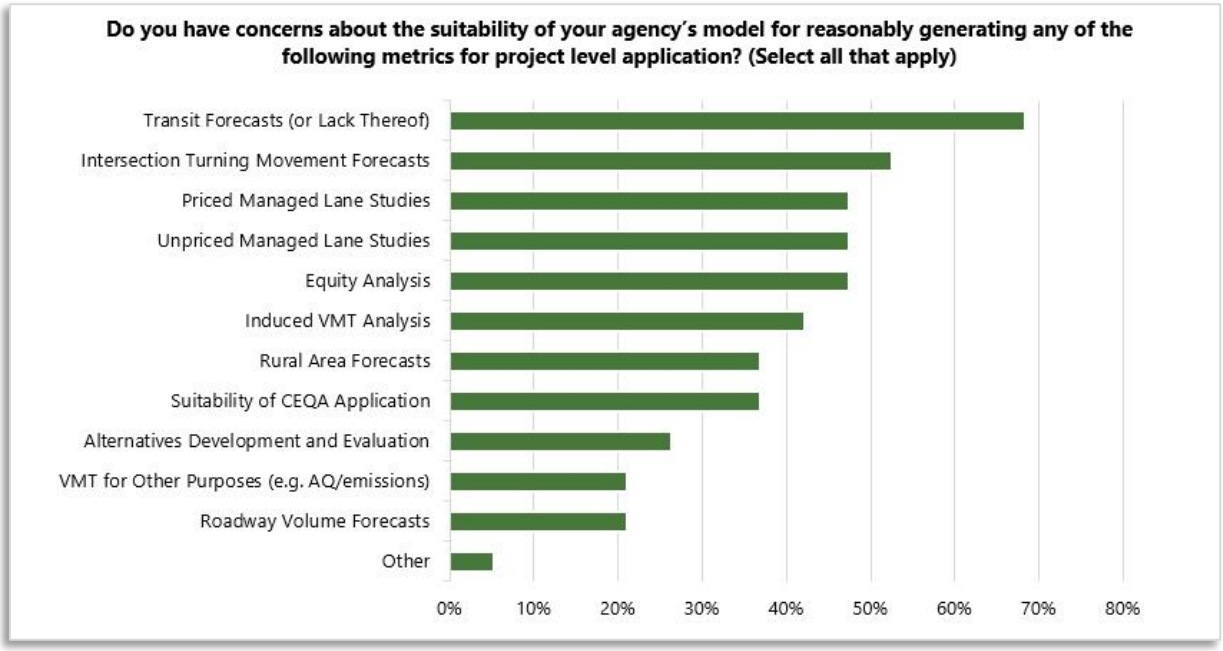

Figure 15: Concerns regarding project-level model applications

In particular, agencies voiced concerns about applying regional models for detailed operational analyses, such as intersection design, turning movement forecasts, and managed lane studies. Despite these concerns, models are frequently used in project-level analyses to inform the design of

intersections and highway segments. This practice raises significant concerns, especially when such applications are conducted without appropriate sub-area validation and calibration. These issues highlight the need for more rigorous guidelines and review practices when using regional models for detailed project-level applications. Additional insights from interviews and model reviews are presented in the following sections. These concerns highlight the limitations of existing models in handling detailed or emerging analysis needs.

While only 45% of survey respondents initially indicated concern about induced VMT forecasting, follow-up interviews revealed broader apprehension—most models do not adequately capture both the short-term and long-term effects of induced vehicle travel.

2.3.10 Future Challenges and Priorities

Looking ahead, agencies identified several challenges and priorities for future model updates. The most common concern, identified by nearly 58% of respondents, was funding, followed by new data collection (53%). About 47% cited concerns about emerging transportation trends, such as electric vehicles (EVs), autonomous vehicles (AVs), and shared mobility services, effects of telework, and micromobility as well as economic changes such as declining gas taxes, tolls, gas prices, VMT taxes, etc.

Insufficient staff time or expertise for managing or overseeing model updates was also a major concern. Around 40% of agencies were concerned about their model's suitability for project-level applications and 37% were concerned about increased model complexity. Overall, agencies face a mix of technical, resource, and institutional challenges as they look ahead to model updates. **Figure 16** shows the survey responses for concerns regarding the next version of the model.

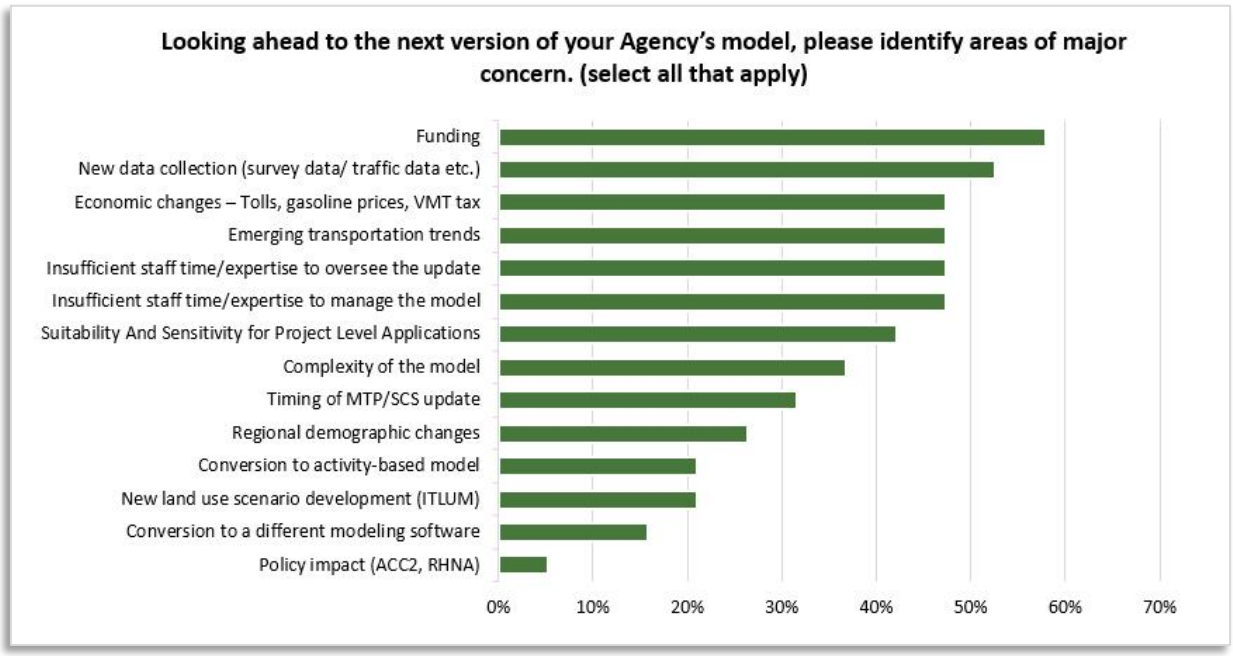

Figure 16: Concerns regarding the next version of the model

These concerns raise an important question for agencies that choose to develop more demanding and complex models such as ABMs. As noted in the regulatory section, the MPO/RTPA staff largely had discretion to design models as they desired. They were not legally required to develop ABMs or other enhanced models. Trip-based models are sufficient for regional modeling requirements. This outcome suggests these agencies may need more assistance, possibly from Caltrans, to align their model design decisions more closely with available resources. Doing so could free up more resources to support project-level model enhancements for Caltrans and local agencies.

2.3.11 Follow-Up

Finally, agencies were asked if they were interested in participating in follow-up interviews to provide deeper insights into their modeling practices and challenges. More than half of the participants were open to discussing their model further. The follow-up interview findings are discussed in the next section.

2.4 Follow-Up Interview Objectives and Design

Follow-up interviews were conducted to gain a deeper understanding of key aspects related to travel demand modeling, including how models are reviewed, developed, and applied, as well as to gather information on planned updates or changes. The interviews also provided an opportunity to clarify survey responses and explore topics that could not be fully addressed in the written format. After the survey, interested participants were contacted by email to schedule the interviews, which were conducted virtually through Microsoft Teams and typically lasted about one hour. The conversational format encouraged more in-depth discussion and allowed participants to highlight specific experiences, challenges, and priorities related to their modeling practices. In addition to collecting insights, the interviews served as a two-way exchange: agencies were able to ask questions about the process, and we had the opportunity to share background on the project—its purpose, scope, and intended outcomes. See **Appendix B** for details on outreach and interview participation.

2.5 Key Findings from Follow-Up Interviews

Interviews were conducted with representatives from 14 MPOs and RTPAs. **Figure 17** geographically shows participating agencies. The findings from these interviews are grouped into several key areas as outlined below:

2.5.1 Model Base Years and Scenario Development Practices

MPOs/RTPAs develop land use scenarios aligned with their RTP/SCS, typically requiring model users to utilize predefined scenarios. Few agencies allow or support external consultants or agencies with flexibility to tailor unique project-specific land use scenarios. This standardized approach ensures consistency but constrains the ability of consultants to accurately reflect localized or project-specific land use dynamics in their analyses. TDM base years adequate for regional plan and SCS analyses were often too old and stale for project-level analyses. Additionally, mandated project analysis years rarely aligned with the MPO/RTPA regional analysis years. This issue will be discussed further in Chapter 4.

2.5.2 Use of Models for Project-Level Analysis

Most agencies indicated their models were developed primarily for regional-level analyses rather than for detailed, project-specific applications. While a limited number of MPOs provide technical support to onboard Caltrans District staff or their consultants in use of the off-the-shelf regional TDM, no MPO/RTPA provides guidance to adapt the TDM for use in project-level analysis. MPOs/RTPAs rarely provide formal reviews or validations of consultant-prepared project-level analyses. Agencies expect consultants or external model users to independently validate model results and adjustments. Reasons cited for limiting their role to regional planning tasks, and avoiding project-level guidance and review roles, include staffing and scheduling constraints; avoidance of perceived bias due to direct involvement in a small number of projects, when the MPO/RTPA role is to maintain independent review of all nominated projects; and lack of training in project-level analysis.

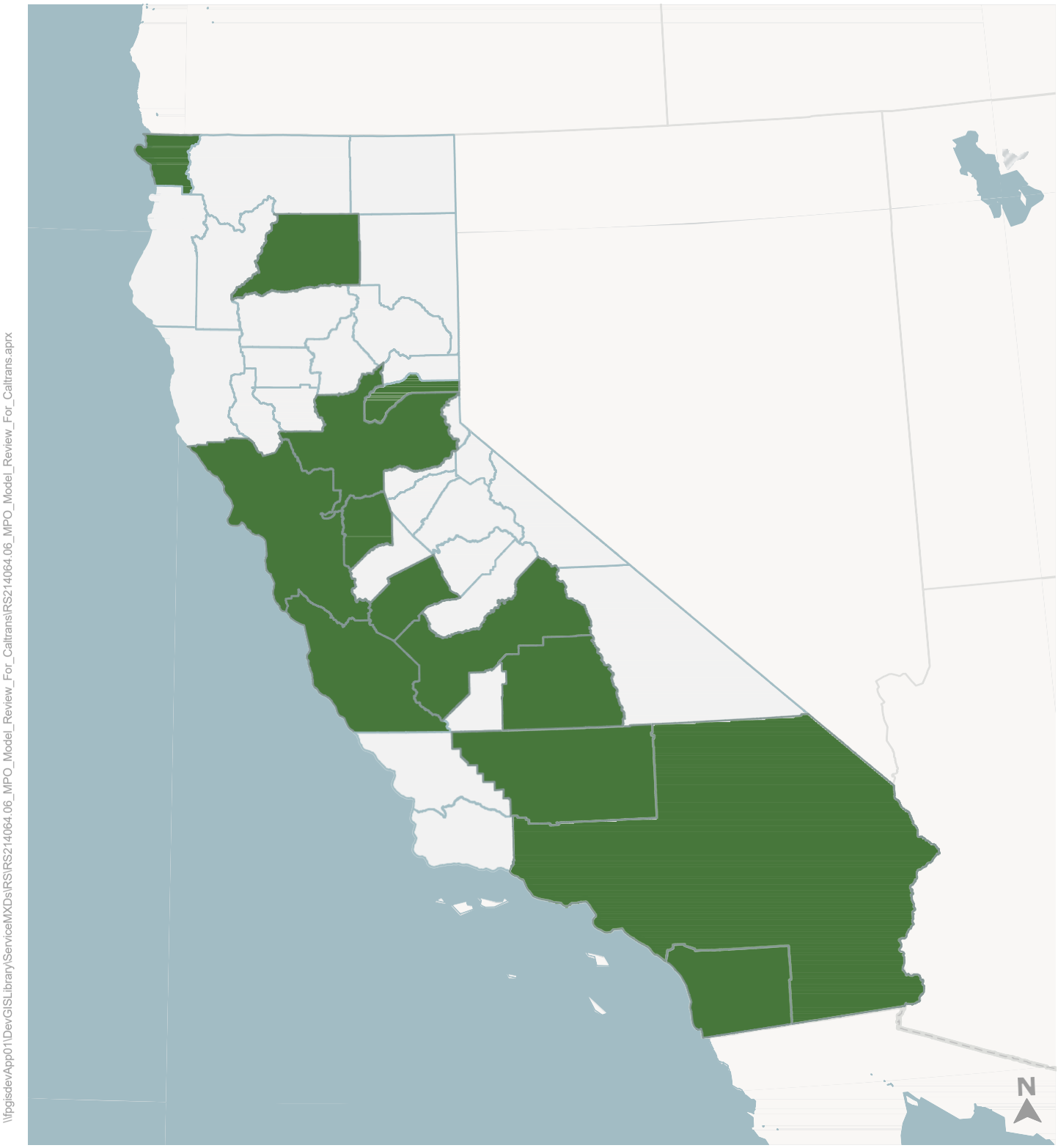

Figure 17

MPOs and RTPAs Interviewed

2.5.3 Guidance and Review

Agencies noted the absence of standardized procedures for reviewing external model applications by consultants or other entities. Currently, most models do not have any formal guidance for project-level applications. However, industry guidance is available for project-level travel forecasting through entities including the Transportation Research Board (TRB), NCHRP, Institute of Transportation Engineers, and Caltrans.

Resource constraints, funding limitations, and staffing shortages were commonly cited as reasons for this gap. However, agencies expressed interest in receiving Caltrans support and guidance to establish robust standards and guidelines for more accurate, transparent, and validated model applications at the project level. As noted above, the resource constraints are somewhat self-imposed given the agency's discretion in deciding what type of model to develop.

2.5.4 Benchmarking, Validation, and Transparency

Discussions revealed that formal benchmarking or standardized validation practices are generally lacking across MPOs. "Benchmarking" is a formalized process for a newly trained TDM user to compare their test model run results of a known scenario against output files provided by the MPO or RTPA, to ensure the user is running the TDM correctly. "Validation" refers to the process of comparing the results of the model, either static or dynamically, to empirical values, to ensure reasonableness of the model as an forecasting tool. MPOs and RTPAs follow state guidance and current practices to conduct model validation for regional purposes; however, does not mean that models are fully validated against the guidance criteria. Separate project validation and reasonableness checking (i.e., sub-area validation) should be done prior to use of a regionally focused TDM for a project-level analysis. While technical assistance for external users is provided, subject to other demands on staff time, most MPOs do not enforce clear benchmarks or validation standards. Public availability of detailed modeling outputs remains limited, and where available, external users typically assume the responsibility of validating model results independently. Agencies acknowledged this limitation and attributed it primarily to resource constraints and institutional practices, noting that these factors limit the consistency and transparency of model applications across different projects.

2.5.5 External Travel and Data Sources

The focus of this discussion was to understand how models account for external travel, i.e., trips that either begin within model boundary and end outside (IX) or begin outside the boundary and end within (XI). Most MPOs reported using statewide travel models, traffic counts, and regional travel survey data to estimate external trips. However, nearly all interviewed agencies terminate the length of those trips and the external VMT calculations at their respective model boundaries or gateways. This practice can lead to incomplete representation of VMT, especially for projects near model boundaries or in areas heavily influenced by external travel flows. A handful of MPOs mentioned using big data sources like Replica to estimate the full length of travel.

2.6 Induced VMT Forecasting and Compliance

Interviews highlighted significant variation and inconsistency in methodologies for forecasting induced VMT across MPOs. Most MPOs only analyze induced VMT at a regional scale, lacking detailed procedures suitable for individual project-level evaluations. Some agencies expressed skepticism regarding the accuracy and applicability of simplified induced VMT calculators, particularly noting their limitations in capturing rural travel dynamics. Only a few MPOs use more advanced, hybrid approaches—combining both model-based outputs and elasticity-based methods—for projects such as freeway expansions. However, none of the interviewed agencies consistently apply a standardized, rigorously validated approach to induced VMT analysis at the project-level, reflecting ongoing uncertainty about best practices and methodological reliability.

3. Review of Travel Demand Models

This section summarizes a review of six regional travel demand models. Because Caltrans projects span both urban and rural areas, the review included models from large MPOs such as SCAG, MTC, and SACOG, as well as models representing more diverse geographies and travel markets. The purpose of the review was to gain a deeper understanding of each model's structure, capabilities, and limitations—particularly for project-level applications. Although these models are primarily designed for long-range regional planning, they are frequently adapted for use in project-specific analyses, such as forecasting roadway volumes, VMT, and assessing environmental impacts under CEQA. The review evaluated how well the models support these applications, especially when inputs are modified to reflect project-specific characteristics. Findings are based on available documentation and interviews with model owners and operators. The goal is to introduce recommendations for improving modeling practices, enhancing transparency, and supporting more reliable project-level transportation impact assessments.

A close examination of model details is essential, as regional models vary widely in structure, inputs, parameters, and design features. Identifying the most relevant travel demand model is a critical first step in ensuring the integrity of transportation project analysis, especially for Caltrans projects, where performance metrics like VMT, congestion, and emissions must be evaluated for design and CEQA purposes. Understanding how a model is configured helps determine whether it can appropriately reflect the project's scale, location, complexity, and intended outcomes.

Model configuration or design is often a function of its scope in terms of what travel demand questions it is intended to answer. The regulatory framework presented above involves relatively straightforward questions that can be answered with trip-based models (TBMs). However, larger MPOs have developed more complex activity-based models (ABMs) that capture more detailed individual travel behavior and responses to policy, pricing, or infrastructure changes. Regardless of model type, it is critical to understand how the model represents all travel demand components (e.g., residents, workers, students, visitors, goods movement, and special generators). Further, users must have a thorough understanding of how to modify all model inputs and parameters such as land use, demographics, socio-economics, network attributes (including pricing), , and treatment of visitors and goods movement. These elements directly affect key output metrics, including peak hour congestion, induced travel, and other measures used to evaluate project impacts.

The six regional TDMs included in this model review process are listed in **Table 1**, along with some high-level information about the models. **Figure 18** graphically shows the MPOs whose models were reviewed.

Table 1: Model Information

MPO	SACOG	MTC	SCAG	SJCOG	TCAG	SANDAG
Model Version: Version control is important to ensure consistency, transparency, and reproducibility of results.	SACSIM19 (2020 MTP)	MTC TM1.5.2 (2021 RTP)	2019 SCAG ABM (2024 RTP)	SJCOG TCM VMIP 2 (2022 RTP)	MIP 2 (2018 RTP)	SANDAG ABM 2+ (2021 RTP)
Type of Model (TBM vs ABM): The distinction between TBMs and ABMs is important because it affects how well the model captures the complexity of human travel behavior. Trip based models are aggregate in nature predicting travel demand from land use, demographic, and socioeconomic variables measured at the traffic analysis zone (TAZ) level. ABMs model individuals and the travel demand derived from their activities.	Activity-based	Activity-based	Activity-based	Trip-Based	Trip-Based	Activity-based
Model Software: The TDM software affects the model's structure, capabilities, how results are process and interpreted, and skillset required by the users. Different software platforms have varying tools, assumptions, and flexibility. Understanding whether the model is script- or catalog-based[1] also helps gauge how customizable the modeling process is.	Cube 6.4.4 Script	Cube 6.4.5 Script	TransCAD 8b	Cube Catalog	Cube 6.1.1 Catalog	EMME 4.3.7
Activity Generation Software: For ABMs, this component of the model estimates the daily activities individuals are likely to undertake. The software used varies in structure and complexity, including how it handles individual and household characteristics, time-of-day choices, toll or cost sensitivity, and linkages between activities.	DAYSIM	CTRAMP	PopGen	N/A	N/A	PopSyn

Notes:
SACOG – Sacramento Area Council of Governments
MTC – Metropolitan Transportation Commission
SCAG – Southern California Association of Governments
SJCOG – San Juaquin Council of Governments
TCAG – Tulare County Association of Governments
SANDAG – San Diego Association of Governments
[1] Script-based TDMs use custom-coded scripts to control model steps, offering flexibility but requiring more programming knowledge.
Catalog-based Cube TDMs use a visual interface with predefined modules and workflows, making them easier to use and maintain but less flexible for customization.

Figure 18

MPO Models Reviewed

3.1 Review Metrics and Criteria

To assess whether regional TDMs are suitable for analyzing Caltrans transportation projects, a comprehensive set of criteria was established for this assessment. These criteria evaluate various dimensions essential for effective model application and project-level analysis considering CEQA compliance and Caltrans design expectations. The evaluation criteria can be grouped into five main categories, each described in detail below.

3.1.1 Model Documentation

Clear, comprehensive, and publicly accessible documentation is critical to the effective and transparent application of TDMs. CARB's technical methodology for evaluating SCSs specifically states that regional models must be well-documented to support review and approval processes. Similarly, CTC's RTP Guidelines emphasize the need for travel models to include detailed development and validation reports. FHWA, and Caltrans recommend or conditionally require documentation to meet certain standards or funding eligibility.

This review category assesses the availability and completeness of essential documentation, including model development reports, installation guides, and user guides. Detailed documentation facilitates appropriate model application, ensures reproducibility, and enhances credibility among stakeholders and the public. Models lacking sufficient documentation can contribute to errors in applications and introduce the risk of misinterpretation.

3.1.2 Model Year Alignment

NCHRP, FHWA, CTC, and ARB all emphasize the importance of using up-to-date travel demand models, though they do not mandate fixed calibration or validation intervals. NCHRP and FHWA recommend recalibrating and validating models whenever there are significant changes in land use, travel behavior, or transportation networks, and specify that models should use the most current available data to ensure reliable forecasts. Similarly, CTC advises that models be updated and validated in coordination with the development of RTP/SCSs, typically on a four-year cycle. CARB expects models used in SCS evaluations under SB 375 to be calibrated and validated using the most recent data available and to be fully documented. In general, state of the practice guidance supports using a base year within the past five years (more recent if a significant change in travel has occurred) and a horizon year that aligns with the most recently adopted RTP/SCS.

This review category assesses the model's base year and horizon year to ensure consistency with current planning practices and regulatory expectations. It also examines when the model was last calibrated and validated, as these processes are critical for confirming that the model accurately reflects observed travel behavior and system performance. A recent base year (typically within the past five years) helps ensure the model reflects current conditions, while alignment of the horizon year with the most recently adopted RTP/SCS supports consistency with long-range planning assumptions. Reviewing the recency of calibration and validation helps determine whether the model remains technically sound and appropriate for use in project-level or regional analysis.

3.1.3 Model Performance against Available Guidance

The credibility of TDM forecasts depends significantly on rigorous validation and calibration practices. The model validation should include static and dynamic tests. Static and dynamic validation tests should include those specified in 2024 RTP Guidelines[13] (CTC 2024) and Travel Model Validation and Reasonableness Checking Manual, Second Edition[14] (FHWA 2010). Static tests verify that the model can match base year traffic counts closely while dynamic tests verify that the model contains an appropriate level of sensitivity related to the types of transportation network or land use changes associated with the project. These tests are particularly important for projects involving mixed-use development projects, highway expansion projects, tolling projects, or multiple modes.

Under this category, the model's historical performance, calibration processes, and validation results are examined. Robust validation and sensitivity analyses, including the assessment of inherent variability or "noise" in activity-based models, are essential for the reliability and stability of model predictions. A model's responsiveness to policy and network changes, tested through documented sensitivity analyses, is also essential, ensuring it can reliably capture the impacts of various project scenarios and policy interventions. This review category assesses the documented validation and sensitivity tests performed at both regional and project level.

This category also assesses the model's capabilities to generate different VMT metrics consistent with SB 743 and capacity to include induced VMT effects. Induced VMT refers to VMT that results from expanding roadway capacity, such as building new highways or adding lanes. When driving becomes faster or more convenient, people tend to drive more, leading to an increase in overall travel that offsets the intended congestion relief. This increase can happen in the short term as drivers take more frequent or longer trips, shift travel times, or switch from other modes like transit to driving. Over the long term, roadway expansion can influence land use patterns by encouraging more spread-out development, leading to longer commutes and greater reliance on personal vehicles.

[13] 2024 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations, https://dot.ca.gov/programs/transportation-planning/division-of-transportation-planning/regional-and-community-planning/rtp-guidelines-update

[14] Travel Model Validation and Reasonableness Checking Manual, Second Edition, https://connect.ncdot.gov/projects/planning/tpb%20training%20presentations/fhwa%20model%20validation%20handbook.pdf

3.1.4 Modeling Detail

A model's effectiveness in forecasting project travel demand effects relies extensively on how it represents the real world through its input data, parameters, and algorithms. The combination of these components defines the model's capabilities, sensitivity to changes, and suitability for specific applications. Key criteria within this category include the model's capability to accurately represent the transportation network, land use, demographics, socioeconomic conditions, the value of time, and the cost of travel. The transportation networks (especially for the cumulative scenario) should only contain planned improvements based on financial constraints that are likely to occur by the cumulative year. This is often referred to as being reasonably foreseeable. The horizon year land use and socioeconomic forecasts need to be based on reasonable market conditions that reflect past and future development trends (as well as past project approvals) for the specific study area and address the potential of the proposed project to induce a different development pattern. The same concept applies to other model inputs for the cumulative year. Input variables should only be changed if supported by substantial evidence.

According to the TAF and the TAC guidance by Caltrans, the transportation network for cumulative scenarios should include only planned improvements deemed financially feasible (reasonably foreseeable). Additionally, input variables should be adjusted only when supported by substantial evidence, reinforcing the accuracy and defensibility of forecasts required under CEQA Guidelines (§15151).

Moreover, models must account for these factors dynamically, ensuring travel demand outputs appropriately reflect the magnitude and direction of input changes. Rigorous validation, including sensitivity testing and assessments of inherent variability, strengthens model reliability and credibility, aligning with the best practices suggested by the NCHRP Report 765 (2014) and FHWA guidelines.

3.1.5 Model Sub-Modules

Sub-modules cover other sources of travel demand not contained by the core model and support features necessary for the core model to run. The assessment considers the presence, quality, and functionality of sub-modules, such as those used for freight and commercial vehicle movements, population synthesizer or land use module, airport travel sub-module, visitor travel sub-model, internal/external travel sub-model, and toll sub-model. These specialized sub-modules enhance a model's capability to perform detailed analyses critical for complex projects. Evaluating the robustness and integration quality of these sub-modules ensures the model can adequately address specific transportation impacts and policy questions relevant to Caltrans. This assessment criteria reviews the availability and dynamic nature of the following sub-modules:

- Commercial Vehicle Sub-Module: Captures freight and service vehicle movements, accounting for distinct travel patterns, vehicle types, and delivery behavior. A dynamic commercial vehicle module is essential for accurate emissions modeling, congestion analysis, and infrastructure planning per FHWA and CARB guidance.
- Population Synthesizer/Land Use Model: Generates detailed household and demographic data for travel demand estimation. Availability of this module supports land use sensitivity and scenario testing useful for SB 375.

- Airport Travel Model: Models passenger and employee trips to and from airports. A dynamic airport module is critical for assessing regional traffic impacts and infrastructure needs.
- Visitor Travel Sub-Modul: Represents non-resident travel, including seasonal and event-driven trips. It is important for accurately forecasting travel demand, especially in tourist or recreational areas.
- Internal/External (IX/XI) Travel Model: Captures IX/XI trips from all demand segments including residents, workers, students, visitors and commercial, ensuring accurate modeling of travel flows crossing regional boundaries. A dynamic IX/XI module supports compliance with regional planning and forecasting practices and ensures impacts are captured beyond the modeling boundary.
- Toll Model: Simulates traveler responses to tolling and congestion pricing. Necessary for evaluating managed lanes, pricing strategies, and revenue impacts.

Table 2 summarizes the findings for each metric within the four categories. Models are reviewed for each metric and given one of the following assessments:

N/A (Metric Not Applicable for this model)	Yes (Model includes/passes assessment metric)	Incomplete (Model includes/ passes some components of the assessment metric)	No (Model does not include/pass assessment metric)

Appendix C has additional notes for the assessment.

Table 2: Model Assessment Checklist

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	MTC TM 1.5.2	SCAG ABM	SJCOG TCM VMIP 2.0	TCAG MIP 2.0	SANDAG ABM2+
Model Documentation									
Complete Model Documentation is available	Model Development Report	Model provides a development report that includes methodology, validation reports, and model performance. For CEQA and planning use, this report helps ensure transparency, replicability, and appropriate use of the model.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Model Installation Guide	A publicly accessible model installation guide ensures that users can run the model and replicate results. This should include software, versions, and computing environment requirement as well as proper guidance on how to install them.	Moderate	Yes	Yes	No	No	Yes	Yes
	Model User Guide	A model user guide provides guidance on how to apply the model including how to update necessary modeling components. A well-documented user guide would provide guidance on all aspects of the model including how to edit land uses, demographics/socioeconomics, population synthesis, special generator, external workers, commercial vehicle trips, etc.	High	Incomplete	Incomplete	Incomplete	No	Incomplete	Incomplete
	Guidance on project-level application	A model user guide on project-level application provides guidance on sub-area calibration/validation, how to change model inputs and parameters, and how to prepare and evaluate model outputs.	High	No	No	No	No	Incomplete	No
	Data Dictionary	Provides clarity on the data variables, definitions, and relationships used in the TDM, which aids users in accurately interpreting the data, ensuring consistent application, and enhancing the overall reliability of analyses and outcomes.	High	Yes	Yes	Yes	Yes	Yes	Yes
All model files are actively maintained, organized, and are available	Input files	Provides the required model input variables in the appropriate format to execute the model.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Output files	Allows users to replicate results and compare findings, fostering trust in the model's stability.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Intermediate files	Allow users to follow the data transformation throughout the modeling process.	High	Yes	Incomplete	Yes	Yes	Yes	Yes
All Model files are available for scenario years	Base Year	Base year refers to the year in which current travel patterns, population data, land use, and other relevant factors are measured or observed. It serves as the starting point for forecasting future travel demand and is used to calibrate the model by comparing projected data to actual observed data.	**High**	Yes (2016)	Yes (2015)	Yes (2019)	Yes (2016)	Yes (2015)	Yes (2016)
	Interim Year	Interim year refers to a year or set of years (both land use and network) between the base year and the horizon year. This is especially important for Caltrans projects where an opening year scenario is needed.	**Moderate**	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
	Horizon Year	The horizon year refers to the target year for which future travel patterns and demand are projected, typically based on RTP or MTP/SCS.	**High**	Yes	Yes	Yes	Yes	Yes	Yes

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	MTC TM 1.5.2	SCAG ABM	SJCOG TCM VMIP 2.0	TCAG MIP 2.0	SANDAG ABM2+
Model Year Alignment									
Model base year is within the past 5 years		Establishes confidence that the model's base year is a relevant foundation for assessing changes under future conditions. Base year needs to be more current when substantial disruptions like COVID-19 occur.	High	No	No	No	No	No	No
Model horizon year aligns with the latest published MPO RTP/SCS		MPOs design models to review their RTP/SCS. Horizon year should reflect "reasonably foreseeable" land use growth and network changes based on financial constraints.	High	Yes	Yes	Yes	Yes	Yes	Yes
Completed calibration and validation within the past 5 years (regional and project-level)	Calibration	Model's parameters and algorithms were adjusted within the last 5 years to match observed travel behavior and traffic conditions.	High	No	Incomplete	No	No	No	No
	Static Validation (Daily)	Model's outputs were compared against observed data, such as traffic counts, trip lengths, and transit ridership within the last 5 years. AM and PM peak hour/period statistical validation tests were done.	High	Incomplete	Incomplete	Incomplete	Incomplete	No	Incomplete
	Static Validation (AM and PM Peak)		High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
	Dynamic Validation/Sensitivity Tests	Model's ability to respond in the correct direction and magnitude to changes in inputs, such as land use, network, travel cost, or value of time were tested within the last 5 years.	Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete
Dynamic/sensitivity tests were performed (regional and project-level)	Demographic Changes	Tested if models are sensitive to changes in population characteristics	Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Land use changes	Tested if model is sensitive to changes in the amount, mix, or pattern of development, such as new housing or increased density.	Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Network Changes	Tested if model is sensitive to network additions, subtractions, or modifications.	Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Transit Changes	Tested if model is sensitive to changes in the transit network or service.	Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Model Parameters (Number of Iterations, Relative Gaps, Random Seed etc.)	Tested if model feedback processes especially for distribution and assignment and each an equilibrium convergence that is stable.	Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete
Model Performance against Available Guidance									
Model results can be replicated		Replicability ensures transparency, credibility, and trust in travel demand model results, especially for CEQA compliance.	High	Yes	Incomplete	Yes	Yes	Yes	Yes
Documentation shows the model passes Static Validation		Static validation tests performed include those specified in 2024 CTC and FHWA guidelines and the model passes the tests. All model major highways are included in the tests.	High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
Documentation shows the model is sensitive to dynamic changes	Demographic Changes	Dynamic tests verify that the model contains an appropriate level of sensitivity related to the types of transportation network or land use changes associated with the project. Dynamic validation/sensitivity tests include these validation tests and the model responds appropriately to the input changes.	High	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Land use changes		High	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Roadway Network Changes		High	Incomplete	Incomplete	Incomplete	No	No	Incomplete
	Transit Changes		Moderate	Incomplete	Incomplete	Incomplete	No	No	Incomplete

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	MTC TM 1.5.2	SCAG ABM	SJCOG TCM VMIP 2.0	TCAG MIP 2.0	SANDAG ABM2+
Model can be used to produce different types and scales of VMT	Project-generated VMT	Travel demand and VMT directly associated with a land use project can be isolated	High	Yes	Yes	Yes	Yes	Yes	Yes
	Project effect on VMT	Model-wide VMT with and without the project can be estimated	High	Yes	Yes	Yes	Yes	Yes	Yes
	Total VMT	All passenger and commercial vehicle VMT on a model's network or generated by its land use, population, or employment inputs.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Household Generated VMT	Household generated VMT refers to VMT generated by household residents including non-home-based trips. This is the preferred metric for non-residential land uses.	High	Yes	Yes	Yes	N/A	N/A	Yes
	Home-based VMT	Home-based VMT is VMT associated with trips starting or ending at home, regardless of trip purpose or destination. This captures trips that start at a residence, which is essential for understanding the travel demand by residential locations and trip purposes.	Moderate	Yes	Yes	Yes	Yes	Yes	Yes
	Home-based Work VMT	Home-based work VMT is a subset of home-based VMT, representing trips specifically between home and workplace locations.	Moderate	Yes	Yes	Yes	Yes	Yes	Yes
	Work-Tour VMT	Work-Tour VMT includes total VMT for a complete work-related tour, starting and ending at workplace, including intermediate stops made during the trip. This is the preferred metric for non-residential land uses.	Moderate	Yes	Yes	Yes	N/A	N/A	Yes
Model can be used to generate VMT that includes trip length beyond model or political boundaries.		CARB and OPR guidance stresses the importance of capturing full trip lengths, including portions outside the modeled region when estimating VMT for CEQA purposes. Truncating VMT at the boundary can underestimate total travel, especially for regionally significant or interregional projects.	Moderate	Yes	No	No	Incomplete	No	Yes
Model can be used to analyze short-term and long-term induced travel effects of a roadway capacity project	Model documentation discusses induced VMT	Model documentation explicitly discusses induced VMT.	High	Yes	No	No	No	No	No
	Feedback processes for short-term induced vehicle travel effects	Model includes feedback processes where changes in congested travel times influence the forecasts of trip generation (activities), trip distribution (activity type and location), mode choice, and assignment. Work and school location travel should remain fixed between no build and build model runs for this purpose.	High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
	Feedback processes for long-term induced vehicle travel effects	Model includes feedback processes that influence long-term land use growth allocations and trip generation. Work and school location travel may change between no build and build model runs for this purpose.	Moderate	No	No	No	No	No	No
	Accounts for temporal Variation	Model accounts for shifts in time-of-day travel patterns due to congestion, which can impact peak period and peak hour design volumes.	High	No	No	No	No	No	No
	Includes dynamic traffic assignment (DTA)	Model includes DTA which is necessary to reasonably forecast changes in travel times if congestion extends beyond one peak hour.	Moderate	No	No	No	No	No	No

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	MTC TM 1.5.2	SCAG ABM	SJCOG TCM VMIP 2.0	TCAG MIP 2.0	SANDAG ABM2+
Modeling Detail									
Model has adequate network detail	Roadway network	Collector and above functional class facilities are coded correctly in the model. This ensures the vehicle movement, traffic flow, and congestion patterns can be accurately modeled and forecasted.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Transit network	All transit lines are coded in the model. This allows the model to better capture mode share and changes in travel metrics such as VMT.	High	Yes	Yes	Yes	Incomplete	Yes	Yes
	Active Transportation network	Model accounts for non-motorized travel modes, such as walking and cycling. All roads with bike lanes and walk-bike only routes are represented in the model.	High	Incomplete	No	Incomplete	Incomplete	Incomplete	No
	Tolling facilities	Model includes tolling facilities that appropriately evaluate the effects of tolls on travel behavior and revenue generation.	High	Incomplete	Incomplete	Incomplete	No	Incomplete	Incomplete
	Transportation Analysis Zone (TAZ) Structure	Model TAZ density is appropriately distributed in the model to reflect the density of traffic loading access points throughout the model boundary.	High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
Model scenarios reflect recent travel behavior trends		Model incorporates recent travel behavior trends, especially pre- and post-COVID differences, capture shifts in patterns such as remote work, changes in commuting patterns, etc.	High	No	Incomplete	No	No	No	No
Highway assignment parameters adequate to minimize model noise		Model's settings ensure stable results; model converges with minimal noise	High	Incomplete	Incomplete	Incomplete	No	No	Incomplete
Model Sub-Modules									
Sub-module files and associated user guides are available	Commercial vehicle model	Model includes freight travel demand and supply that appropriately reflect freight travel and delivery activities which is essential for roadway congestion metrics and infrastructure needs	High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
	Population Synthesizer/Land Use model	Model simulates demographic characteristics and household attributes, used to estimate travel behavior and demand. Model includes necessary tools and inputs required to calculate synthetic population.	Moderate	Yes	Incomplete	Incomplete	N/A	N/A	Incomplete
	Airport travel model	Model includes trips associated with air travel, including passengers, goods, and employee movements to and from airports.	Moderate	Yes	Yes	Yes	No	No	Yes
	Visitor travel model	Model includes dynamic sub-module to capture travel behavior of tourists and non-residents, whose trip-making decisions differ from residents.	Moderate	No	No	No	No	No	No
	Internal/external travel model	Model includes a sub-module that captures trips that begin and end outside the study area.	High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
	Toll model	Model includes a sub-module that evaluates the impact of toll roads on travel behavior and route choice	High	Yes	Yes	Yes	No	Yes	Yes

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	MTC TM 1.5.2	SCAG ABM	SJCOG TCM VMIP 2.0	TCAG MIP 2.0	SANDAG ABM2+
Sub-modules are dynamic (changes in land use and network will change these model output)	Commercial vehicle model	Modul adjusts based on changes in road infrastructure (e.g., new highways or tolls) and shifts in land use pattern	High	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete	Incomplete
	Population Synthesizer/Land Use model	Modul dynamically updates population or land use model based on input changes	Moderate	Incomplete	Incomplete	Incomplete	N/A	N/A	Incomplete
	Airport travel model	Changes in airport capacity, expansion projects, or regional infrastructure improvements will dynamically update forecasts.	Moderate	No	No	No	No	No	No
	Visitor travel model	Land use and network changes will alter ground travel patterns of visitors	Moderate	No	No	No	No	No	No
	Internal/external travel model	Regional land use, road networks, or external connectivity (e.g., new bridges or regional rail connections) dynamically change external travel demand.	High	Incomplete	No	No	No	No	No
	Toll model	Toll rates and toll booth placement changes, as well as network modifications (e.g., new toll roads or adjusted routes), will impact on traveler route choices and overall demand.	High	Incomplete	Incomplete	Incomplete	No	Incomplete	Incomplete

Level of Assessment:

N/A (Criteria Not Applicable for this model)	Yes (Model includes/ passes assessment criteria)	Incomplete (Model includes/passes some components of the assessment criteria)	No (Model does not include/pass assessment criteria)

Source: Fehr & Peers, 2025.

3.2 Review Findings

3.2.1 Limited User Documentation and Transparency

Model transparency was a consistent limitation. This lack of transparency undermines the public disclosure objectives of CEQA, making it difficult or impossible for Caltrans or other stakeholders to independently evaluate project-specific modeling results.

- All models have development reports; however, the level of detail in each varies.
- Two out of six models lacked model installation guides. Although these were trip-based models and have relatively simple modeling environment requirements, the installation guide is necessary for ensuring model replicability.
- Five out of six models had user guides; however, in most cases the guidance was incomplete on how to make changes necessary for project-level applications especially those related to land use or related inputs. None of the user guides discussed the stochastic nature of ABMs. Although the variability may not be significant at the regional scale, at project-level, it introduces "model-noise" that can be difficult to isolate from the project effect. This can be minimized by averaging results from multiple runs, but no evidence was presented to verify how many runs were necessary for a statistically valid average.
- All agencies shared basic model input and major output files; however, two agencies did not provide intermediate output files, which could limit detailed project-level analysis and independent validation.
- All models have horizon year forecasts that align with current adopted RTP/SCS.
- Although all models have some interim year scenarios, they often did not match the project-level requirements for the opening year. Some of them only interpolate between base and horizon years and do not include land use and network projections based on reasonably foreseeable conditions tied to the interim year.

3.2.2 Outdated Base Year and Limited Validation

Models were not maintained and validated to a recent base year (within the past five years) and limited validation tests were performed.

- None of the models have a base year within the last five years. Lack of a recent base year means the model may fail to reflect current conditions. This is especially important when substantial disruptions like COVID-19 take place, and autonomous taxis have become more common in the past few years in some regional markets. An older base year also means the model does not reflect current land use and traffic levels. Using an older base year for a project-level application introduces potential misalignment of model results with current travel demand and patterns.
- For five of the six models, calibration and validation efforts were conducted within the past five years as part of a reasonableness check. This process involved comparing recent-year model forecasts (which is newer than the base year) against observed traffic volumes to assess whether the model produces reasonable outputs. While this does not replace a full re-estimation, calibration, and validation based on a new base year, it provides some assurance that the model remains suitable for forecasting. In several cases, minor calibration adjustments were also made to improve model performance. However, it's important to note that the models' base years are still significantly older, meaning current travel trends may not be fully captured. Additionally, validation and sensitivity testing were limited and only performed at the regional level.

3.23 Insufficient Capability for Project-Level Applications

None of the "off-the-shelf" models are suitable for project-level applications due to lack of sensitivity tests at project-level and lack of model capabilities to fully capture induced VMT.

- Although all model documentation includes static validation tests, none of them were comprehensive. The validation was only limited to daily travel; and comparison against the CTC criteria was missing. Peak hour validation was not completed, which is also important for Caltrans design year volumes.
- Most models include some level of sensitivity tests or dynamic validation. However, the level of tests varied significantly. The tests were only performed for daily levels at regional scale. Though models show sensitivity to changes in demographics, land use, and network changes, the tests are not enough to determine model suitability for project-level applications.
- Documentation on transit validation and sensitivity testing were insufficient for project level application. Most static tests occurred at the system level versus individual line or station level. The level of change in transit ridership as a result of roadway network and land use inputs were not specifically tested.
- Apart from the ability to forecast land use changes distinguishing project from no-project conditions, each model provided capabilities for generating VMT metrics consistent with SB 743 requirements. However, only two out of six models had post-processes that capture VMT outside the model boundary. Truncating VMT at the boundary can underestimate total travel, especially for regionally significant or interregional projects.
- Only one out of five model documentations discuss induced travel or induced VMT effects.
- All models are capable of partially accounting for "short-term" induced VMT effects through feedback processes where changes in congested travel times influence the forecasts trip distribution (activity type and location), mode choice, and assignment.
- None of the models are capable of accounting for "long-term" induced VMT effects. In other words, models lack feedback processes that influence long-term land use growth allocations and trip generation.
- Models do not account for shifts in time-of-day travel patterns due to congestion, which impact peak period and peak hour design volumes.
- Models do not include dynamic traffic assignment (DTA) which is necessary to reasonably forecast changes in travel times and demand if congestion extends beyond one peak hour.

3.24 Lack of Geographic and Behavioral Detail

Models lack spatial resolution and fail to reflect current travel behavior shifts.

- The models incorporated detailed traffic analysis zone (TAZ) structures near urban centers but showed reduced spatial detail farther from central areas. This lack of detail may result in incomplete assessment of VMT and mode split when analyzing projects.
- All models coded collector-level and higher-class roadways consistently.
- Tolling mechanisms were included in five out of six models but all of them presume the entire driver population is influenced by toll effects. TRB research shows that some drivers will not use

priced lanes, and that the driver population should be decreased accordingly to avoid overestimating potential demand and revenue.[15]

- Five out of six models do not include any adjustments to post-COVID travel trends such as changes in commuter pattern, changes in shopping pattern, introduction of gig economy, peak spreading, transit ridership changes, etc. One model only captures some adjustments to work from home percentage, but it was not a dynamic component that could be easily modified to test travel behavior.

3.2.5 Incomplete Sub-Modules

Although most models include some sub-modules, in most cases they are not dynamic. In other words, the changes in model inputs do not automatically adjust these modules:

- Although all models include commercial vehicle models, they do not dynamically adjust based on roadway infrastructure changes. Most models do not include increases in delivery vehicles i.e., commercial trip ends at residential location.
- Two out of six models do not include airport-related travel. The four that do, do not dynamically adjust based on changes in regional infrastructure changes.
- None of the models include a visitor model component. This is especially important for regions with tourist attractions.
- All models account for trips outside of model boundaries. However, in most cases, these were static inputs that do not dynamically update based on regional land use and infrastructure changes.

[15] *Unrevealed Preferences: Unexpected Traveler Response to Pricing on Managed Lanes*, 2018 TRB Annual Meeting, Mark Burris and John Brady.

4. Review of Caltrans Projects

This section summarizes the process and key findings from the review of travel demand modeling applications used in recent Caltrans projects. Four completed project analyses were reviewed to assess how MPO TDMs have been applied for analysis of Caltrans projects. The review focused on the acquisition, adaptation, and application of the MPO TDMs, and the uses of the TDM outputs in the project analysis. Four projects are not sufficient to generalize about all applications of TDMs for Caltrans projects, but sufficient to identify issues that arise in doing so. The four projects were selected to get a range of project types and geographic contexts:

- **Project type:**
  - Two projects added managed lanes capacity
  - One project widened general-purpose freeway capacity
  - One project modified and expanded a freeway interchange.
- **Geography:**
  - One project in Northern California
  - One project in Southern California
  - Two projects in the Central Valley
- **Analysis documents:**
  - One project included a Transportation Operations Analysis Report (TOAR)
  - One project included Project Approval and Environmental Document (PA/ED)
  - Three projects included Environmental Impact Report (EIR)
  - Three projects included induced VMT analyses

4.1 Review Process

The review started with acquisition of relevant project analysis documents, starting with publicly available documents. After consultation with Caltrans District project teams, additional documents not publicly available were acquired for some projects. Relevant information sought from project documents included the following:

- "Source" TDM used for project analysis (MPO TDMs in all cases)
- Adaptation of the MPO TDM for use in the project analysis
- Testing and validation of the adapted TDM
- Analysis years relevant to the project (base year/existing conditions, forecast year/future conditions)
- Post-processing and preparation of TDM outputs for use in more detailed traffic analysis software
- Results of alternatives analysis

No project provided all of this information in publicly available documents. Interviews were used to fill in the voids and resolve questions on the publicly available documents. Interviews were requested from the designated Caltrans District project manager. Lists of questions and requests were sent to the project manager, and he or she decided which other district staff or project consultants to

include in interviews. All interviews resulted in additional documentation not available to the public being provided for this review.

4.2 Key Findings Summary

The following issues emerged as projects were reviewed:

4.2.1 Transparency

A lack of transparency was a common issue across reviewed projects. Many did not clearly document the source TDM used for analysis, and few explained modifications made to adapt the regional model for project-level use. Additionally, project documentation often lacked references or links to supporting materials, such as model documentation or technical memoranda, making it difficult for reviewers to trace assumptions, methods, or data sources used in the modeling process.

Concerns:

CEQA, in particular, is about disclosing the potential impacts of a project, with a chance for members of the public to comment. Not providing sufficient information to adequately understand how those potential impacts were analyzed and quantified undermines this goal.

For professional reviewers of Caltrans project reports, not including information on the source of TDMs, significant information like the version of the model used, and links to online references available by MPOs or RTPAs that maintain the source TDM used, prevents the reviewer from understanding and investigating the source TDM used for a project analysis. The lack of this information means Caltrans staff are 'trusting' that the model (off the shelf) is reasonable and suitable for producing design hour volumes and CEQA impact outputs like VMT without verification.

4.2.2 Mismatched Analysis Years

Several reviewed projects used TDMs whose base and forecast years did not align with the analysis years required for the project. In most cases, there was little to no documentation explaining how these discrepancies were addressed. Where documentation was available, the most common approach involved interpolating or extrapolating vehicle trip tables from the source model. For example:

- If project analysis years fell between two forecast years (e.g., 2030 between 2027 and 2035), interpolated trip tables were generated and used in vehicle assignment-only modeling.
- If project analysis year is beyond the model's horizon (e.g., a 2049 project year using a 2040 model forecast), extrapolated trip tables were generated and used in vehicle assignment-only modeling.

Concerns:

Base year traffic conditions reported in CEQA documents and Caltrans project reports are often based on estimates of travel demand from TDMs. A mismatch between the model base year and the project analysis base year could bias the conditions reported.

Interpolation and extrapolation of vehicle trip tables to bridge between or extend past a forecast year for a TDM "freezes" the functionality of the model to account for routing of trips only. Changes in demand springing from trip generation, distribution, or mode choice are omitted. Especially if project/no project runs are compared to estimate project impact, this practice will likely overstate congestion relief provided by a project.

Extrapolation of vehicle trip tables past the horizon year available with the source TDM is particularly fraught with problems and biases. Extrapolating a vehicle trip table past the available horizon year of a source TDM is, literally, assuming both the amount and distribution of growth that would generate additional vehicle trips. MPOs and RTPAs spend considerable time and effort analyzing assumptions about the amount and distribution of growth to the horizon year of the source TDM, providing adequate time for jurisdictions with land use authority to review and comment on these assumptions, and allowing policy makers the opportunity to review and endorse the assumptions for use in transportation planning. Simply extrapolating vehicle trip tables shortcuts this entire process. Not only does this produce uncertain design volumes but would be considered speculation under CEQA. Per CEQA Guidelines Section 15145, "If, after thorough investigation, a lead agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact." Under this condition, it would be more appropriate for Caltrans to limit cumulative impacts to a reasonable horizon year such as that tied to the RTP/SCS.

423 Source Model Validation for Key Purpose and Need Measures

Though congestion is not a metric that can be used for CEQA impact analysis, congestion or proxy measures like "traffic operations" are very commonly referred to in statements of project purpose and need. The analysis for these measures usually relies on estimates of peak period or peak hour demand drawn from TDMs. Source models are rarely validated for peak period or peak hour volumes, with no evidence shown that peak volumes are validated for project analysis.

A similar issue exists for transit demand estimates from source TDMs: "maximizing person throughput" or "optimizing modality" are cited in project purpose and need, requiring estimates for project impact on carpooling and transit, at a minimum. Source models often only validate transit at systemwide level, and project analyses do not provide any evidence of validation of key routes of interest for project analysis. Further, some regional TDMs produce outputs like ridership and VMT that move in the wrong direction when changes are made at the project level.

Concerns:

Source TDMs are developed, calibrated, validated, and tested by MPOs and RTPAs for regional analysis, and in limited cases, for sub-regional analyses. In the best cases, calibration, validation, and testing of models corresponds to the major policy variables the MPO or RTPA is focused on. Though every MPO or RTPA validates traffic assignment against daily volumes, very few validate peak conditions. Daily volumes are required as inputs to vehicle emissions models used for air quality conformity, SB 375 greenhouse gas emissions, and other regional analyses. VMT estimates used for SB 743 analyses by MPOs and RTPAs are based on daily conditions. However, measures of congestion and operational delay used in project analyses require estimates of peak, directional vehicle traffic demand as inputs to Synchro, VISSIM or

other microsimulation tools. Matching daily traffic volumes with reasonable accuracy is not a guarantee of similar accuracy for peak period or peak hour volumes. This is especially true in urban regions with substantial congestion because current models rely on static assignments. This is known limitation that can substantially affect a model's ability to produce reasonable peak hour volumes and even VMT forecasts.[16]

For projects where person throughput or multimodal travel is part of the purpose and need, the ability to predict person trips by mode is necessary. Source TDMs that offer some level of validation by mode of travel (e.g., comparing model commute mode shares to Census journey-to-work, or model trip shares by mode to a recent household travel survey) at the regional level is common. It is also common for source TDMs to validate daily transit boardings by transit service type (e.g., commuter bus, light rail, local fixed-route bus, etc.), but validation is normally done only at the regional level. For projects where the transit service of interest is a handful of routes either using the project facility itself, or on nearby parallel routes, line-level validation is needed to assess reasonability of the source TDM for the project analysis.

424 Accounting for "Noise" in Activity-Based Models

Larger MPOs have switched regional TDMs to some form of ABM, and some medium-sized MPOs have either made the switch or are in process. A key characteristic of activity-based models (ABMs) is that they are stochastic, meaning they incorporate random variation in simulating individual travel behaviors. This randomness is controlled by a "seed" variable—a fixed input number that initializes the random number generator used in the model. By setting a specific seed value, the model can produce consistent and reproducible results across runs with the same inputs. Changing the seed variable alters the sequence of random numbers, leading to different individual-level outcomes in the simulation. While aggregate results may remain similar, variations can occur, especially in smaller study areas or when analyzing specific subpopulations.

At regional level, MPOs have started to develop methods using multiple runs and run aggregation to manage the inherent noise in the TDM. Only one example of an analysis of random noise in an ABM could be found for California MPOs.[17] It showed that random noise varies by metric. For example, at a regional level, VMT varied by +/- 0.04%. Transit trips, though, varied by +/-0.9%. Random noise varies also by geographic scale. VMT for a small population area within the region varied randomly by 0.9%, 20 times more variation than at the regional level. While the percentages may seem small, the region is large, and this level of noise can be larger than the expected effect of an individual project. For all four projects reviewed for this report, roadway segment volumes were by far the most important variables drawn from TDMs. No tests of random noise on estimated roadway segment volumes could be found, but the random variation is likely to be higher for roadway segment volumes, given the scaling effects of random noise.

[16] Forecasting the impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment. Research in Transportation Business & Management, Normal L. Marshall. (2018)

[17] Sacramento Area Council of Governments, https://www.sacog.org/home/showpublisheddocument/1624/638355570142100000

Most project-level analyses rely on build/no-build comparisons to isolate the impact of the project. This involves running a TDM twice, one for the build (i.e., with project) conditions, and one for the no-build (i.e., without project) conditions. However, even with an assumed level of +/- 2% random variation, the difference between single TDM runs (i.e., one run for the build, one run for the no-build) could be off by over 50%, purely by chance (See **Table 3**). Multiple runs for each scenario and averaging of the results is the only way to eliminate this risk. Only one of the four projects reviewed for this study used an ABM, and run averaging (of 3 runs) was done for the VMT mitigation testing only. The initial findings of these runs indicated that more runs are likely necessary to achieve a statistically confident result.

Concerns:

Conclusions about the impact of a project are often based on differences between project analysis scenarios, for which random variation in model runs may obscure the real differences.

4 summarizes some of the major issues with project application.

Table 3: Demonstration of Potential Error Using Single Model Runs for Stochastic Demand Models

Study Area	Area-wide Metrics [1]			Range of Model Estimates				Delta (Build vs No Build)			
	Build	No Build	Average Variation	Build-Low	Build-High	No Build-Low	No Build-High	"Real" Delta[2]	Minimum Delta[3]	Maximum Delta[4]	%Error in Delta
Vehicle Miles Traveled											
Small Project Area	1,000,000	925,000	2.00%	980,000	1,020,000	906,500	943,500	75,000	36,500	113,500	+/- 51%
Large Project Area	5,000,000	4,500,000	1.00%	4,950,000	5,050,000	4,455,000	4,545,000	500,000	405,000	595,000	+/- 19%
Region	50,000,000	47,000,000	0.05%	49,975,000	50,025,000	46,976,500	47,023,500	3,000,000	2,951,500	3,048,500	+/- 2%
Transit Person Trips											
Small Project Area	200	180	50.00%	100	300	90	270	20	**-170**	210	+/- 950%
Large Project Area	1,000	970	5.00%	950	1,050	922	1,019	30	**-69**	129	+/- 328%
Region	100,000	97,000	1.00%	99,000	101,000	96,030	97,970	3,000	1,030	4,970	+/- 66%

Source: Fehr & Peers, 2025.
Notes:
[1]All metrics are assumed values for demonstration purposes, not specific project metrics.
[2] "Real" Delta - Average Build Minus Average No Build
[3] Minimum Delta - Low Build Minus High No Build
[4] Maximum Delta - High Build Minus Low No Build
Bold indicates values that are not consistent with the expected outcome of the project

Table 4: Project Review Summary Table

	Project 1	Project 2	Project 3	Project 4
Documentation	Very little documentation included in project report and website	Most available on project website	Very little documentation included in project report and website	Very little documentation included in project report and website
	Some pieces available by request, others undocumented	Some documents unavailable	Some pieces undocumented	Some documents only available by request
Base Year (BY) Mismatch				
# Years between Source Model BY and Project BY	6	3	3	2
Mismatch resolved by…	Adj. BY model #s	Ignored	Not Known	Ignored
Project Opening Year (OY) Mismatch				
# Years Between Source Model Scenario and OY	0	2	6	7
Mismatch resolved by…	n/a	Interpolation	Growth Factoring	Interpolation
# Years Between Source Model Horizon and OY+20	10	9	3	7
Mismatch resolved by…	Extrapolation	Extrapolation	Growth Factoring	Extrapolation
Purpose and Need (P&N) Elements	Improved Operations	Reduce Congestion	Reduce Congestion	Reduce Congestion
	Reliability	Person Throughput	Safety	Improve Operations
	Person Throughput	Improve Operations	Improve Operations	
Issues Related to Modeling P&N	No Peak Validation	No Peak Validation	No Peak Validation	No Peak Validation
	No Validation of Transit Lines Relevant to Project	No Validation of Transit Lines Relevant to Project		
Level of Concern Color Coding:	Little/No	Minor	Moderate	Major

5. Findings and Recommendations

MPOs in California develop TDMs primarily to support long-range planning efforts such as the RTP/SCS and air quality conformity and to address regional policy questions. While these models, particularly ABMs, are suited for regional analysis, they are often not suitable or reasonable for project-level applications without complete user guides, additional testing, and refinement.

5.1 Challenges and Limitations

Regional TDM application to project-level analysis—such as during the Caltrans project approval/environmental document (PA/ED) phase—presents significant technical and procedural limitations. These issues were identified through review of models and modeling practices on recent Caltrans projects. Core challenges include behavioral misrepresentation, the dominance of model noise over project-level signals, a lack of technical alignment in forecasting assumptions, and major environmental blind spots. Despite this, these models are necessary to support project-level impact assessments for Caltrans projects, including greenhouse gas emissions, air quality, energy, noise, safety, and traffic operations. Several critical challenges emerge when regional models are applied to project-level contexts:

- **Model Purpose and Project Purpose Misalignment**: Regional models are calibrated and validated at an aggregate level. They are not intended for fine-grained, project-specific applications, yet are often used "off-the-shelf" for this purpose without appropriate adjustments or documentation. Sub-area validation, which can improve forecast accuracy, is often not conducted for project-level applications.
- **Lack of Documentation**: Models lack documentation for project-level applications. Modifications made by users when analyzing a project are rarely documented and reviewed, undermining CEQA's disclosure requirements. MPOs generally avoid oversight of project-level applications of their models, due in part to political sensitivities with local jurisdictions.
- **Lack of Sub-Area Validation:** Surveyed agencies indicated that their "off-the-shelf" model is not suitable for project-level application. If models are being used to analyze impacts at a local level, sub-area validations should be performed. The reviewed projects did not provide documentation on sub-area validations.
- **Analysis Year Misalignment and Workarounds**: Required analysis years for project environmental documents (base year, opening year, and 20-year horizon) rarely align with the years modeled by regional travel demand models. Inconsistent and poorly documented methods are used to interpolate or extrapolate to the correct years, often freezing key model components and diminishing or eliminating responsiveness to changes in land use or network conditions.
- **Stochasticity and Lack of Multi-Run Averaging**: ABMs include random elements that can yield significantly different outputs across model runs, even with identical inputs. While averaging results over multiple runs can mitigate this variability, most project-level analyses rely on a single model run due to budget and time constraints—resulting in outputs where model "noise" may overshadow actual project effects.
- **Inadequate Validation for Project-Level Metrics**: Models are typically validated using daily traffic volumes at the regional level. "Off the shelf" models are not suitable for producing key project-level needs—such as Caltrans peak hour design volumes, turning movements, congestion levels,

and VMT outputs for environmental impact analysis. At a minimum, additional dynamic validation testing that considers project type, travel demand outputs, and time periods to inform needed refinements is necessary within each project study area.

- **Induced Travel Not Fully Represented**: Most models lack sensitivity to short- and long-term induced travel. Interpolated/extrapolated scenarios are not able to capture induced travel, and land use changes resulting from transportation investments are entirely omitted. No MPO travel demand model currently supports dynamic land use response at the project level.
- **Truncation of VMT at Regional Boundaries**: All reviewed models stop tracking vehicle miles traveled (VMT) at the regional boundary. This overlooks induced interregional travel, which can be significant for some projects (e.g., Riverside–San Bernardino travel on I-15). SACSIM is the only model that post-processes VMT beyond the gateway.
- **Lack of DTA:** Models do not include DTAs to reasonably forecast changes in travel times if congestion extends beyond one peak hour. As a result, peak hour assignments can produce travel times exceeding one hour. This means that demand is overestimated and is likely to shift to other hours. In extreme conditions, congestion may suppress some demand, which results in overestimation of congestion during specific peak hours. Both of these effects can influence peak hour design volume and daily VMT forecasts.
- **Incorporation of Post-Pandemic Trends is Limited**: Most models have not been updated to reflect new travel patterns such as remote work, e-commerce, and peak spreading brought on by the COVID-19 pandemic. Only one model was found to partially incorporate tele-commuting behavior.
- **Incorporation of other Travel Trends is Limited**: Most models do not reflect new travel patterns such as increased delivery trips, gig economy, changes in transit use, TNCs, autonomous taxis, micromobility, etc.
- **Operations Analysis Amplifies Upstream Errors**: Project-level traffic operations tools (e.g., VISSIM) use travel demand model outputs as inputs. Inaccuracies in demand forecasts, especially in peak hour volumes or turning movements—can propagate and worsen downstream operational findings.
- **Inflexible Sub-Models**: Sub-models like freight, visitors, and airport users are often handled through static sub-models or fixed assumptions. These modules are frequently undocumented, unvalidated, and insensitive to changes in transportation infrastructure or policy.
- **Limited MPO Support and Legal Framework**: MPOs provide little guidance for adapting models to project needs. Only MTC and possibly SCAG offer any formal support or documentation. There is no legal requirement for model accuracy or fitness-for-purpose outside of CCA conformity obligations.

5.2 Recommendations

Regional TDMs have not been designed to produce project-level travel demand outputs. Part of the reason is because there is no requirement to do so. Their design has been determined largely based on the needs and preferences of the regional agency. In addition, Caltrans has not considered alternative modeling approaches for their projects. With many of the MPOs/RTPAs reporting concerns about adequate resources for continued development, maintenance, and use of their current models, a dialogue with Caltrans and other model stakeholders like local agencies should be considered. This could help better align future model development/designs that are responsive to regional and local/project needs while also addressing funding constraints. Alternatively, Caltrans can develop its own models for project development and environmental review purposes that utilize only those components from the regional TDMs that are directly applicable.

To improve the applicability, reliability, reasonableness, and suitability of regional TDMs or to develop alternative models for project-level applications, Caltrans can pursue the following options.

- **Adapting Regional TDMs for Project Applications**
  - Coordinate with MPOs and RTPAs to assess their current models and the level of effort required to adapt them for project-level applications. Include other stakeholders like local agencies to assess their project-level needs.
  - Evaluate if model development and application funding is sufficient for MPOs and RTPAs based on their legal/regulatory forecasting requirements. Determine what additional cost would be incurred if current models were updated to include project-level needs. If more funding is required, assess if it can be met by administrative reallocation of funding from existing programs or if legislative solutions should be pursued to increase funding.
  - Consider new legislation that would provide funding support for regional agencies (or Caltrans) to maintain project-level models.
  - Consider a Caltrans-led statewide modeling technical assistance program to continually monitor and refine the model recommendations from this study.
  - Evaluate automating many of the land use and network changes common in project applications similar to the tools created by SACOG.[18]
  - Update the 2024 Regional Transportation Plan Guidelines (for both MPOs and RTPAs) to include the expectation that model development must include user guides with complete instructions for how to appropriately apply the model for regional and project-level applications. The update should also include technical specifications for peak period/hour static validation, project-level dynamic validation testing, typical project-level refinements, when to include a DTA, and how to extract output variables used for Caltrans design and environmental review purposes. All this information should be made easily available through MPO/RTPA and Caltrans websites. Coordinate with CARB on withholding SCS approvals until this information is available.
  - Rigorously apply the TAF model review checklist and verify findings before starting project-level forecasts for design or environmental impact analysis purposes. Recognize that all models in the state do not include feedback processes to land use growth allocation or trip generation and would not pass the checklist tests off the shelf.

[18] https://www.sacog.org/planning/data-resource-center/transportation-analysis-modeling

  - Recommend the use of DTAs in urban areas where congestion spreads to multiple hours in each peak period. Collaborate with Caltrans academic partners like U.C. Berkeley to improve DTA models such as Mobility for project level applications.[19] Guidance on preparing demand estimate to be used for DTA (generally from a regional TDM adapted for use in the project) should be provided.
  - When analyzing short-term induced VMT effects of a project in the opening year, it is important to keep work and school locations fixed between the no-build and build model scenarios. This is because significant changes in where people work or attend school are unlikely to occur immediately as a result of a new transportation project. Allowing the model to reallocate these could inaccurately attribute VMT changes to shifts in land use that would not realistically happen in the short term. Freezing these locations ensures that the analysis isolates the effect of transportation network on route choices and congestion, without conflating them with longer-term land use dynamics.

- **Developing Alternative Models for Project-Level Applications**
  - Support the development of models explicitly designed for project-level applications in Caltrans districts where sufficient project development warrants. Some sub-regional agencies like the Western Riverside Council of Governments (WRCOG) and Riverside County Transportation Commission (RCTC) follow this approach. Caltrans could support local transportation agencies in the development of these models or create their own versions similar to the Lake-Mendocino TDM developed by Caltrans District 1. These models could be derivatives of regional TDMs or stand-alone models, but they would be focused on producing the outputs needed for Caltrans design volumes and induced VMT.
  - Update the statistical research supporting the California Induced Travel Calculator to focus on California counties/regions using more recent data, separating urban and rural areas, and adding context variables such as project types (e.g., new lane, widened lane, or bridge). Once complete, update the Calculator Tool accordingly with separate elasticities for urban versus rural areas and project types.
  - Conduct new research on induced vehicle travel effects on increased passenger vehicle driving to isolate the effects on trip generation versus trip distribution.

All recommendations should include close coordination with the California Air Resources Board (CARB), given their interest and role in regional modeling.

[19] https://its.berkeley.edu/node/13412

Statement on Conflict-of-Interest Management

Several of the projects included in this study were originally analyzed by Fehr & Peers. To ensure the integrity and objectivity of our review, we implemented measures to avoid any actual or perceived conflict of interest. All projects were evaluated with the same level of rigor and impartiality, regardless of our firm's involvement in their original analysis. Importantly, our review was limited to publicly available documentation to maintain transparency and uphold professional standards.

APPENDIX A

Agencies Surveyed

Mariposa County Local Transportation Commission – Mariposa LTC
Southern California Association of Governments – SCAG
Sierra County Transportation Commission – SCTC
Shasta Regional Transportation Agency – SRTA
Metropolitan Transportation Commission – MTC
Kern Council of Governments – Kern COG
Kings County Association of Governments – KCAG
Butte County Association of Governments – BCAG
Lassen County Transportation Commission – LCTC
Siskiyou County Local Transportation Commission – SCLTC
Tulare County Association of Governments – TCAG
Modoc County Transportation Commission – Modoc CTC
Fresno Council of Governments – Fresno COG
Association of Monterey Bay Area Governments – AMBAG
Merced County Association of Governments – MCAG
Humboldt County Association of Governments – HCAOG
Madera County Transportation Commission – Madera CTC
Sacramento Area Council of Governments – SACOG
Tahoe Regional Planning Agency – TRPA
Placer County Transportation Planning Agency – PCTPA
San Diego Association of Governments – SANDAG
San Joaquin Council of Governments – SJCOG
Caltrans District 1 – Caltrans D1
Del Norte Local Transportation Commission – Del Norte LTC
Nevada County Transportation Commission – NCTC

Agency	1. Do you have a Travel Demand Model for your MPO/RTPA?	2. If No, is there any other local/regional model that you use?	3. Please provide the name and the latest version of the model you use in your jurisdiction.	4. Who manages the model files and documentations?	5. What are your legal/regulatory requirements for developing and applying the model?
Mariposa LTC	No	No	-	-	-
SCAG	Yes		SCAG 2024RTP Model	Agency	Federal requirement for Regional Transportation Plan - Transportation Conformity Rule (40 CFR Part 93) - It requires the use of transportation models to estimate emissions from mobile sources for conformity determinations. California Sustainable Communities Strategy - model requirements for California's SCS under SB 375 are outlined through guidance issued by the CARB.
SCTC	No	No	-	-	-
SRTA	Yes		SHASTASIM V.2.0	Consultants	The requirements outlined in the Caltrans 2024 RTP guidelines for MPOs.
MTC	Yes		Travel Model One v1.6	Agency	California RTP Guidelines (https://dot.ca.gov/programs/transportation-planning/division-of-transportation-planning/regional-and-community-planning/rtp-guidelines-update) California SCS Guidelines (https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources)
Kern COG	Yes		2020 Base, soon to use 2023 Base	Agency	RTP, FTIP, air conformity etc.
KCAG	Yes		CUBE	Consultants	Air quality conformity, SCS evaluation
BCAG	Yes		BCAG 2024 RTP Travel Demand Model v2.0	Consultants	Federal Transportation Conformity and State SB 375
LCTC	No	No	-	-	-
SCLTC	No	No	-	-	-
TCAG	Yes		San Joaquin Valley Model Improvement Program Phase 2 (MIP2)	Agency	TCAG has been operating under the Group C2 requirements per the 2024 CTC RTP Guidelines. However, as of the 2020 Census, the TCAG region no longer meets the criteria to be designated a TMA. Therefore, the Group B2 requirements apply. TCAG has not made significant changes to the modeling program, so far, as a result.
Modoc CTC	No	No	-	-	-
FresnoCOG	Yes		Fresno ABM, version 2024	Agency	Caltrans RTP Guidelines served as the basis for the development of our travel demand model.
AMBAG	Yes		2022 AMBAG RTDM	Agency	As an MPO for the development of region's long range transportation plan and sustainable community strategy
MCAG	Yes		MCAG travel demand model, v1, Amendment FTIP2025	Agency	by state and federal requirements
HCAOG	No	No	-	-	-
Madera CTC	Yes		Madera County Travel Demand Model	Agency	Title 40, Chapter I, Subchapter C, Part 93, Subpart A
SACOG	Yes		Draft SACSIM23 (to be adopted in 2025) adopted model SACSIM19 (adopted 2020)	Agency	As MPO maintain updated model for RTP. Follow CTC travel demand model RTP guidelines. Submit model and documentation as part of SCS, Air Quality Conformity and MTP documents.
TRPA	Yes		TransCAD 9.0, Tahoe Travel Demand Model	Agency	
PCTPA	No	Yes	SacSim19	SACOG staff	We are an RTPA within an MPO so we have to maintain consistency with the MPO.
SANDAG	Yes		SANDAG ABM3	Agency	Demonstrate State (SB 375) and Federal air quality standards. Quantify the impacts of the regional plan.
SJCOG	Yes		VMIP2	Mixture of Agency and Consultant	US Clean Air Act, federal air quality conformity requirements, state greenhouse gas targets (SB 375)
Caltrans District 1	Yes		There are three: Humboldt County TDM (2015 BY), Del Norte TDM (BY 2010) and Lake-Mendocino TDM (BY 2019)	Caltrans District 1	None that I know of. We just maintain the models and keep them as current as we can as a normal part of System Planning.
Del Norte LTC	No	HPMS VMT estimates are used to ground truth.	We do not use a model.	Agency	
NCTC	Yes		TRANSCAD 8.0	Agency	NCTC is not required to have a TDM, but utilizes in long range transportation forecasting and identification of the regional transportation deficiencies that based on the latest planning assumptions are forecasted to occur based on demographic and land use growth assumptions. It is also used to establish a legal nexus for the local and regional transportation fee program capital improvements and to determine the percent attributable to development. It is also used for both CEQA analysis of both transportation and land use projects to identify potential impacts associated with LOS as it applies to General Plan policies, VMT, air quality, and GHG. It is also utilized for Federal Air Quality Conformity analyses utilizing the latest planning assumptions to determine if regionally significant transportation non-exempt projects do not impact the non-attainment areas ability to meet federal air quality standards for ozone. The model is validated and calibrated to existing local conditions.

Agency	6. What are the key planning priorities for which the model is an important planning or analysis tool?	7. Do you provide your agency's model to other agencies or their consultants, for analysis of their programs or projects?	8. Which of these following are available either publicly or upon request? (Select all that apply)	9. Is the "Off-the-shelf" model (the model version managed by the MPO/RTPA without modification) adequate for application of any of the following project type? Please select all that apply.	10. When was the model last calibrated and validated?
Mariposa LTC	-	-	-	-	-
SCAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.)	Yes - All input and major output files only	Model Files - All input and all output files Model Development Report SCAG Model can be requested, Model Validation Report, Model Specification Report, Model Test Report	RTP/SCS	Within the last two years (post-pandemic)
SCTC	-	-	-	-	-
SRTA	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.)	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Model User Guidelines	RTP/SCS Transportation Network Projects (Roadway Expansion or Road Diet) Alternatives Development and Evaluation CEQA Analysis – Traffic (VMT) Other VMT	Three to five years ago
MTC	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Transportation project analysis	Yes - All input and major output files only	Model Files - All input and all output files Model Development Report Model User Guidelines	RTP/SCS Transportation Network Projects (Roadway Expansion or Road Diet) Unpriced Managed Lane Studies Priced Managed Lane Studies Land Use/ Development Projects Alternatives Development and Evaluation	Within the last two years (post-pandemic)
Kern COG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis	Yes - All input and major output files only	Model Files - All input and all output files Model Development Report	RTP/SCS Transportation Network Projects (Roadway Expansion or Road Diet) Alternatives Development and Evaluation Land Use/ Development Projects CEQA Analysis – Traffic (VMT) Active Transportation Projects (Bike/ Ped / Transit Infrastructure) Fright Clean Air Act Analysis	Three to five years ago
KCAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Transportation project analysis	Yes - All input and major output files only	Model User Guidelines Model Files - All input and all output files	RTP/SCS Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) Land Use/ Development Projects CEQA Analysis – Traffic (VMT) CEQA Analysis – Noise And AQ	Six to ten years ago
BCAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.)	Yes - All input and major output files only	Model Development Report Model User Guidelines Model Files - All input and all output files	RTP/SCS Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) Clean Air Act Analysis	Within the last two years (post-pandemic)
LCTC	-	-	-	-	-
SCLTC	-	-	-	-	-
TCAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis	No	Model Development Report Model User Guidelines	RTP/SCS Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) Land Use/ Development Projects CEQA Analysis – Traffic (VMT)	Six to ten years ago

Agency	6. What are the key planning priorities for which the model is an important planning or analysis tool?	7. Do you provide your agency's model to other agencies or their consultants, for analysis of their programs or projects?	8. Which of these following are available either publicly or upon request? (Select all that apply)	9. Is the "Off-the-shelf" model (the model version managed by the MPO/RTPA without modification) adequate for application of any of the following project type? Please select all that apply.	10. When was the model last calibrated and validated?
				Active Transportation Projects (Bike/ Ped / Transit Infrastructure) CEQA Analysis – Noise And AQ	
Modoc CTC	-	-	-	-	-
FresnoCOG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Transportation project analysis	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Model User Guidelines Guidance on project level application Transportation Analysis Guidelines	Model needs some modifications for all of these applications	Within the last two years (post-pandemic)
AMBAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Model User Guidelines	RTP/SCS Transportation Network Projects (Roadway Expansion or Road Diet) Alternatives Development and Evaluation Land Use/ Development Projects CEQA Analysis – Noise And AQ Clean Air Act Analysis	Three to five years ago
MCAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.)	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Model User Guidelines	RTP/SCS CEQA Analysis – Traffic (VMT) Other VMT Transportation Network Projects (Roadway Expansion or Road Diet)	Within the last two years (post-pandemic)
HCAOG	-	-	-	-	-
Madera CTC	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Model User Guidelines	RTP/SCS Alternatives Development and Evaluation Clean Air Act Analysis CEQA Analysis – Noise And AQ CEQA Analysis – Traffic (VMT) Transportation Network Projects (Roadway Expansion or Road Diet) Land Use/ Development Projects	Three to five years ago
SACOG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Model User Guidelines Provide trainings for project level use support, but do not say if you should or should not use model for project level application or transportation analysis.	RTP/SCS Model is validated at regional level for RTP/SCS use and available for and available for other analysis use. Should always use expert judgement if appropriate for studies/analysis listed. Model has been used for all analysis listed here but do not recommend off the shelf without further detailed calibration and or validation based on study needs.	Within the last two years (post-pandemic)
TRPA	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.)	No	Model Development Report Model Files - All input and all output files	RTP/SCS Model not designed for individual project analysis, but can do most of the above when several are grouped together	Within the last two years (post-pandemic)
PCTPA	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis development impact fees	No	SACOG handles all of this	see SACOG's answers	Unsure
SANDAG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies	Yes - All input and major output files only	Model Files - All input and all output files Model Development Report Model User Guidelines	RTP/SCS Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) Unpriced Managed Lane Studies	Within the last two years (post-pandemic)

Agency	6. What are the key planning priorities for which the model is an important planning or analysis tool?	7. Do you provide your agency's model to other agencies or their consultants, for analysis of their programs or projects?	8. Which of these following are available either publicly or upon request? (Select all that apply)	9. Is the "Off-the-shelf" model (the model version managed by the MPO/RTPA without modification) adequate for application of any of the following project type? Please select all that apply.	10. When was the model last calibrated and validated?
				Priced Managed Lane Studies Land Use/ Development Projects	
SJCOG	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis	Yes - All input and all output files	Model Files - All input and all output files Model User Guidelines Model Development Report	RTP/SCS Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) Clean Air Act Analysis CEQA Analysis – Noise And AQ CEQA Analysis – Traffic (VMT) Land Use/ Development Projects for managed lanes project analyses, project sponsor has modified the existing model for project use	Within the last two years (post-pandemic)
Caltrans District 1	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis	Yes - All input and major output files only	Model Files - All input and all output files Model Development Report Model User Guidelines Component of Sea Level Rise analysis	Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) Land Use/ Development Projects CEQA Analysis – Traffic (VMT) Fright Other VMT Clean Air Act Analysis	Unsure
Del Norte LTC	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.)	Unsure	Everything that I have is available to the public.	RTP/SCS	Unsure
|NCTC	Regional analysis (Regional Transportation Plan, Transportation Improvement Program, Sustainable Community Strategy, air quality conformity, etc.) Corridor plans or other sub-regional studies Transportation project analysis land use project analysis (CEQA), mitigation fee programs	Yes - All input and all output files	Model Files - All input and all output files Model Development Report Mode User Guidelines Guidance on project level application Transportation Analysis Guidelines	RTP/SCS Alternatives Development and Evaluation Transportation Network Projects (Roadway Expansion or Road Diet) CEQA Analysis – Traffic (VMT) CEQA Analysis – Noise And AQ Safety Fright Clean Air Act Analysis Other VMT Land Use/ Development Projects Priced Managed Lane Studies Unpriced Managed Lane Studies Mitigation Fee Program Nexus & Air Quality Conformity Analysis	Within the last two years (post-pandemic)

Agency	11. What metrics were included in the static validation? (select all that apply)	12. Were any dynamic validation or sensitivity tests performed?	13. If Yes, please list all the metrics included in the dynamic validation or sensitivity tests.	14. Do you develop separate land use scenarios for your different transportation scenarios for RTP/SCS?	15. Does your model include any post pandemic adjustments?
Mariposa LTC	-	-	-	-	-
SCAG	Trip Generation Trip Distribution Mode Share Traffic volumes Transit volumes Speed Trip Length VMT Please check SCAG validation report	Yes	Auto operating cost (by fuel price and fuel efficiency), highway/arterial capacity, transit service frequency, transit fare, household income, work from home, tele-medicine, variables by TAZ (household density, bikelane density, parking cost), Cordon pricing, TDM, ...	No	No
SCTC	-	-	-	-	-
SRTA	Traffic volumes Transit volumes	Yes	Dynamic land use testing	Yes	No
MTC	Mode Share Traffic volumes Transit volumes	Yes	We haven't completed these yet, but they will be performed as they're required for the SCS Evaluation. We perform sensitivity tests for inputs that are related to Plan strategies.	Yes	Yes
Kern COG	Trip Generation Trip Distribution Mode Share Traffic volumes Transit volumes Speed Trip Length VMT	Unsure		Yes	No
KCAG	Trip Generation Trip Distribution Traffic volumes	Unsure		Yes	No
BCAG	Traffic volumes	Yes	Induced Vehicle Travel (short-term), Auto Operating Cost, Land Use, and Income.	Yes	Yes
LCTC	-	-	-	-	-
SCLTC					
TCAG	Trip Generation Trip Distribution Mode Share VMT Trip Length Transit volumes Traffic volumes	Yes	Sensitivity tests were done during the review of the TCAG 2022 SCS by CARB.	Yes	No
Modoc CTC	-	-	-	-	-
FresnoCOG	Trip Generation Mode Share Speed Trip Length Traffic volumes Transit volumes Trip Distribution VMT	Yes	Auto operation cost, transit fare, new transit service, transit frequency, road diet, new bike lanes, HOV lanes, managed lanes/toll pricing, truck restrictions, capacity increase, new employment, and change of speeds.	Yes	No
AMBAG	Trip Generation Trip Distribution	No		Yes	No

Agency	11. What metrics were included in the static validation? (select all that apply)	12. Were any dynamic validation or sensitivity tests performed?	13. If Yes, please list all the metrics included in the dynamic validation or sensitivity tests.	14. Do you develop separate land use scenarios for your different transportation scenarios for RTP/SCS?	15. Does your model include any post pandemic adjustments?
	Mode Share Traffic volumes Transit volumes Speed Trip Length VMT		VMT sensitivity to AOC sensitivity to land use		
MCAG	Trip Generation Trip Distribution Traffic volumes Mode Share VMT	Yes		Yes	No
HCAOG	-	-	-	-	-
Madera CTC	Trip Generation Trip Distribution Mode Share Transit volumes Traffic volumes Speed Trip Length VMT	Yes	Households +/-, Lanes +/-, add/remove links, transit headway increase/decrease	Yes	No
SACOG	VMT Trip Length Speed Transit volumes Traffic volumes Mode Share Trip Distribution activity model validated to household travel survey activity time of day diary not explicitly trip generation.	Yes	• Add a lane to a link • Delete a lane to a link • Change link speeds • Change link capacities • Managed lanes (pricing and vehicle eligibility) • Regional accessibility (or “destinations”) • Mix of use (or “diversity”) • Proximity to transit (or “distance”) • Street pattern (or “design”) • Residential density • Employment density • Auto operating costs • Off-street parking price • Transit fares • Transit services (headway changes) • Add/remove transit lines • Improved access to transit • Household income • Increase/decrease shares of teleworking • Random seed variation • Induced demand (VMT to lane miles, Speed to Capacity, VMT to Speed) • VMT, transit trips, walk trips, CVMT, Transit Person Trips, bike trips	Yes	Yes
TRPA	Trip Distribution Traffic volumes Transit volumes	Yes	Not yet finalized, as model update is in progress. Items included in the previous RTP and included in this cycle's validation include but are not limited to: adding population to a single TAZ, increasing transit service frequency, and changing recreational attractiveness of a zone.	No	Yes
PCTPA	see SACOG's answers	Unsure		Yes	Yes

Agency	11. What metrics were included in the static validation? (select all that apply)	12. Were any dynamic validation or sensitivity tests performed?	13. If Yes, please list all the metrics included in the dynamic validation or sensitivity tests.	14. Do you develop separate land use scenarios for your different transportation scenarios for RTP/SCS?	15. Does your model include any post pandemic adjustments?
SANDAG	Trip Generation Trip Distribution Mode Share Traffic volumes Transit volumes Trip Length VMT	Yes	Impacts of EVs on eVMT, e-bike ownership effects, and telecommute sensitivity tests.	Yes	Yes
SJCOG	Trip Generation Trip Distribution Mode Share Traffic volumes Transit volumes Speed Trip Length VMT	Unsure		Yes	No
Caltrans District 1	Traffic volumes Trip Length Trip Distribution	No	-	Yes	No
Del Norte LTC	Unsure	Unsure	-	No	No
NCTC	Trip Generation Trip Distribution Traffic volumes Trip Length	Yes	Two tests were done: • Test 1 - Adding 50 single family and 50 multi family dwelling units to zone 228 in Grass Valley • Test 2 - Expand Hwy 49 to 4 lanes	Yes	Yes

Agency	16. If Yes, please specify.	17. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for program or plan level application? (Select all that apply)	18. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for project level application? (Select all that apply)	19. Looking ahead to the next version of your Agency's model, please identify areas of major concern. (select all that apply)	20. Would you like to be contacted for a more thorough interview regarding your model and process?
Mariposa LTC	-	-	-	-	-
SCAG		Intersection Turning Movement Forecasts Suitability of CEQA Application	SCAG model is validated at regional level, so the model is designed for regional analysis. However, SCAG model has been shared with many consultants for analyzing their projects. The model should work for project-level application, but it may need additional calibration ro adjustment. Intersection Turning Movement Forecasts	Timing of MTP/SCS update Regional demographics changes Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL New data collection (survey data/ traffic data etc.) Suitability And Sensitivity of The Model for Project Level Applications Policy impact (ACC2, RHNA), change in post-pandemic travel pattern	Yes
SCTC	-	-	-	-	-
SRTA		Induced VMT Analysis Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Rural Area Forecasts Equity Analysis	Suitability of CEQA Application Alternatives Development and Evaluation Induced VMT Analysis Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Rural Area Forecasts Equity Analysis	New data collection (survey data/ traffic data etc.) New land use scenario development (ITLUM) Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax Regional demographics changes New state requirements passed via legislation in 2024 or may be passed in the future that may impact RTP planning process.	Yes
MTC	We represent increased working-from-home as well as post-pandemic mode preference changes.	Intersection Turning Movement Forecasts	Intersection Turning Movement Forecasts Our model is a regional model, so it's not appropriate for small projects. Suitability of CEQA Application Alternatives Development and Evaluation Induced VMT Analysis VMT for Other Purposes (e.g. AQ/emissions) Roadway Volume Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Rural Area Forecasts Equity Analysis	New data collection (survey data/ traffic data etc.)	Yes
Kern COG		Unpriced Managed Lane Studies Priced Managed Lane Studies	Priced Managed Lane Studies Unpriced Managed Lane Studies	Conversion to activity-based model Conversion to a different modeling software (e.g., TransCAD to Cube)	Yes
KCAG		Induced VMT Analysis Intersection Turning Movement Forecasts Transit forecast (or lack thereof) Equity Analysis	Induced VMT Analysis Intersection Turning Movement Forecasts Transit forecast (or lack thereof) Equity Analysis	Timing of MTP/SCS update Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time Understanding of Model Components / Complexity of the model Suitability And Sensitivity of The Model for Project Level Applications Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax	No

Agency	16. If Yes, please specify.	17. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for program or plan level application? (Select all that apply)	18. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for project level application? (Select all that apply)	19. Looking ahead to the next version of your Agency's model, please identify areas of major concern. (select all that apply)	20. Would you like to be contacted for a more thorough interview regarding your model and process?
BCAG	Model has been calibrated to year 2022 (post pandemic)	Induced VMT Analysis Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Equity Analysis	Suitability of CEQA Application Alternatives Development and Evaluation Induced VMT Analysis VMT for Other Purposes (e.g. AQ/emissions) Roadway Volume Forecasts Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Rural Area Forecasts Equity Analysis	Timing of MTP/SCS update Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time Understanding of Model Components / Complexity of the model Suitability And Sensitivity of The Model for Project Level Applications New data collection (survey data/ traffic data etc.) New land use scenario development (ITLUM) Economic changes – Tolls, gasoline prices, VMT tax Regional demographics changes	No
LCTC	-	-	-	-	-
SCLTC	-	-	-	-	-
TCAG		Intersection Turning Movement Forecasts Priced Managed Lane Studies	Suitability of CEQA Application Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies	Suitability And Sensitivity of The Model for Project Level Applications Conversion to activity-based model Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax	Yes
Modoc CTC					No
FresnoCOG		Induced VMT Analysis Transit forecast (or lack thereof)	Transit forecast (or lack thereof)	Timing of MTP/SCS update Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time Understanding of Model Components / Complexity of the model Conversion to a different modeling software (e.g., TransCAD to Cube) Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax Regional demographics changes	Yes
AMBAG		Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof)	Intersection Turning Movement Forecasts Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Equity Analysis	Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time New data collection (survey data/ traffic data etc.) Understanding of Model Components / Complexity of the model Conversion to activity-based model Conversion to a different modeling software (e.g., TransCAD to Cube) Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax	Yes
HCAOG	-	-	-	-	-

Agency	16. If Yes, please specify.	17. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for program or plan level application? (Select all that apply)	18. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for project level application? (Select all that apply)	19. Looking ahead to the next version of your Agency's model, please identify areas of major concern. (select all that apply)	20. Would you like to be contacted for a more thorough interview regarding your model and process?
MCAG		Alternatives Development and Evaluation Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Equity Analysis	Induced VMT Analysis Unpriced Managed Lane Studies Priced Managed Lane Studies Transit forecast (or lack thereof) Rural Area Forecasts Equity Analysis VMT for Other Purposes (e.g. AQ/emissions) Roadway Volume Forecasts Intersection Turning Movement Forecasts Alternatives Development and Evaluation Suitability of CEQA Application	Funding Suitability And Sensitivity of The Model for Project Level Applications New data collection (survey data/ traffic data etc.) New land use scenario development (ITLUM) Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL	Yes
Madera CTC		Transit forecast (or lack thereof) Priced Managed Lane Studies Unpriced Managed Lane Studies	Transit forecast (or lack thereof) Priced Managed Lane Studies Unpriced Managed Lane Studies	Timing of MTP/SCS update Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time Understanding of Model Components / Complexity of the model Suitability And Sensitivity of The Model for Project Level Applications Conversion to activity-based model Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax	No
SACOG	Telework trends from local survey and ACS data.	These is always uncertainty forecasting metrics for application, in particular the further out the forecasts the more uncertainty. Level of disaggregation, certainty and precision needs should to be thought out before using any model metric outputs such as VMT and turning movement forecasts.	These is always uncertainty forecasting metrics for application, in particular the further out the forecasts the more uncertainty. Level of disaggregation, certainty and precision needs should to be thought out before using any model metric outputs such as VMT and turning movement forecasts.	Timing of MTP/SCS update Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time New data collection (survey data/ traffic data etc.) Economic changes – Tolls, gasoline prices, VMT tax Conversion to a different modeling software (e.g., TransCAD to Cube)	Yes
TRPA	Partial recalibration of O-D trip patterns, adjustments to account for businesses that closed	Equity Analysis Rural Area Forecasts Transit forecast (or lack thereof) Unpriced Managed Lane Studies Priced Managed Lane Studies Intersection Turning Movement Forecasts Roadway Volume Forecasts VMT for Other Purposes (e.g. AQ/emissions) Induced VMT Analysis Alternatives Development and Evaluation Suitability of CEQA Application	Equity Analysis Rural Area Forecasts Transit forecast (or lack thereof) Priced Managed Lane Studies Unpriced Managed Lane Studies Intersection Turning Movement Forecasts Roadway Volume Forecasts VMT for Other Purposes (e.g. AQ/emissions) Induced VMT Analysis Alternatives Development and Evaluation Suitability of CEQA Application	Funding New data collection (survey data/ traffic data etc.) Suitability And Sensitivity of The Model for Project Level Applications Economic changes – Tolls, gasoline prices, VMT tax Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Insufficient staff time/expertise to manage and sustain the model over time Regional demographics changes Insufficient staff time/expertise to oversee the update Only one staff member deals with the model, only a portion of this person's job, not enough staff time to use for more than RTP	No
PCTPA	I am not sure, see SACOG's answer.	see SACOG's answer	see SACOG's answer	see SACOG's answer	No

Agency	16. If Yes, please specify.	17. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for program or plan level application? (Select all that apply)	18. Do you have concerns about the suitability of your agency's model for reasonably generating any of the following metrics for project level application? (Select all that apply)	19. Looking ahead to the next version of your Agency's model, please identify areas of major concern. (select all that apply)	20. Would you like to be contacted for a more thorough interview regarding your model and process?
SANDAG	Telecommuting, daily activity patterns, and mode share.	Intersection Turning Movement Forecasts Rural Area Forecasts	Suitability of CEQA Application Intersection Turning Movement Forecasts Transit forecast (or lack thereof) Rural Area Forecasts	Understanding of Model Components / Complexity of the model Suitability And Sensitivity of The Model for Project Level Applications New data collection (survey data/ traffic data etc.)	Yes
SJCOG		Induced VMT Analysis Transit forecast (or lack thereof)	Transit forecast (or lack thereof) Induced VMT Analysis	Funding Conversion to activity-based model Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Economic changes – Tolls, gasoline prices, VMT tax	No
Caltrans District 1		Transit forecast (or lack thereof) Equity Analysis Bicycle & Pedestrian Forecasts	Bicycle & Pedestrian Forecasts Transit forecast (or lack thereof) Equity Analysis	Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time New data collection (survey data/ traffic data etc.) New land use scenario development (ITLUM) Emerging transportation trends - EVs, AVs, Telework, micromobility, Shared ride services (Uber/Lyft), VTOL Regional demographics changes Economic changes – Tolls, gasoline prices, VMT tax Lack of any Bicycle & Pedestrian Output	Yes
Del Norte LTC		Rural Area Forecasts Equity Analysis Induced VMT Analysis	Induced VMT Analysis Rural Area Forecasts Equity Analysis	Funding Insufficient staff time/expertise to oversee the update Insufficient staff time/expertise to manage and sustain the model over time Understanding of Model Components / Complexity of the model	Yes
NCTC	Updated traffic counts	Transit forecast (or lack thereof)	Transit forecast (or lack thereof)	Funding	Yes

APPENDIX B

Table A. MPO/RTPA Survey Communication Records

Original Survey Sent on 11/18/2024	Original Survey Resent (due to Out of-office or bounceback emails) on 11/22/2024	Original Survey Resent (due to Out of-office or bounceback emails) on 11/20/2024	Survey Reminder Sent 11/22/2024	Survey Reminder Sent 11/26/2024	Survey Reminder Sent 11/27/2024	Survey Reminder Sent 12/02/2024	Survey Reminder Sent 12/17/2024
aorfila@sbcag.org babraham@sanbenitocog.org bhattarai@fresnocog.org blasagna@bcag.org bpatel@ambag.org christina@tamcmonterey.org dgrossi@co.tuolumne.ca.us dpedersen@modoctransportation.com dylan@maderactc.org eflickinger@kerncog.org ehahn@stancog.org ekelly@calacog.org Elizabeth.forte@mcagov.org felicia@actc-amador.org HU@scag.ca.gov jclayton@mariposacounty.org jkreitz@mono.ca.gov jlfcleric@gmail.com jriskegomez@tehamartpa.org jschmid@trpa.gov Kloeb@sjcog.org ldaveybates@dbcteam.net lisa.buglewicz@dot.ca.gov lzorn@bayareametro.gov marcovelazquez@countyofplumas.com melissa@siskiyoucoltc.org merrante@inyocounty.us mjazevedo@countyofcolusa.org mmoeinaddini@srta.ca.gov mthomas@countyofglenn.net mwoodman@nccn.net oona.smith@hcaog.net programming@sccrtc.org publicworks@sierracounty.ca.gov rbrady@tularecog.org rcarter@pctpa.net sacsim@sacog.org slocog@slocog.org spekaj@dow-associates.com ssaad@trinitycounty.org tamera@dnltc.org terri.king@co.kings.ca.us twoodrow@alpinecountyca.gov wdeloria@edctc.org ziying.ouyang@sandag.org	anderson@sjcog.org borroum@comcast.net wrush@sbcag.org	cherimartin7@outlook.com genevieve@lsctrans.com	amelia@tamcmonterey.org anderson@sjcog.org aorfila@sbcag.org babraham@sanbenitocog.org bhattarai@fresnocog.org blasagna@bcag.org borroum@comcast.net bpatel@ambag.org cherimartin7@outlook.com christina@tamcmonterey.org dgrossi@co.tuolumne.ca.us dpedersen@modoctransportation.com dylan@maderactc.org eflickinger@kerncog.org ehahn@stancog.org ekelly@calacog.org Elizabeth.forte@mcagov.org felicia@actc-amador.org genevieve@lsctrans.com HU@scag.ca.gov jclayton@mariposacounty.org jkreitz@mono.ca.gov jlfcleric@gmail.com jriskegomez@tehamartpa.org jschmid@trpa.gov Kloeb@sjcog.org ldaveybates@dbcteam.net lisa.buglewicz@dot.ca.gov lzorn@bayareametro.gov marcovelazquez@countyofplumas.com melissa@siskiyoucoltc.org merrante@inyocounty.us mjazevedo@countyofcolusa.org mmoeinaddini@srta.ca.gov mthomas@countyofglenn.net mwoodman@nccn.net oona.smith@hcaog.net programming@sccrtc.org publicworks@sierracounty.ca.gov rbrady@tularecog.org rcarter@pctpa.net sacsim@sacog.org slocog@slocog.org spekaj@dow-associates.com ssaad@trinitycounty.org tamera@dnltc.org terri.king@co.kings.ca.us twoodrow@alpinecountyca.gov wdeloria@edctc.org wrush@sbcag.org ziying.ouyang@sandag.org	amelia@tamcmonterey.org anderson@sjcog.org aorfila@sbcag.org babraham@sanbenitocog.org bhattarai@fresnocog.org blasagna@bcag.org bpatel@ambag.org bsana@sandag.org cherimartin7@outlook.com christina@tamcmonterey.org corrales@sjcog.org dgrossi@co.tuolumne.ca.us dpedersen@modoctransportation.com dylan@maderactc.org eflickinger@kerncog.org ehahn@stancog.org ekelly@calacog.org Elizabeth.forte@mcagov.org felicia@actc-amador.org genevieve@lsctrans.com HU@scag.ca.gov jclayton@mariposacounty.org jkreitz@mono.ca.gov jriskegomez@tehamartpa.org jschmid@trpa.gov kshipley@sacog.org ldaveybates@dbcteam.net lisa.buglewicz@dot.ca.gov lzorn@bayareametro.gov marcovelazquez@countyofplumas.com meg.prince@mcagov.org melissa@siskiyoucoltc.org merrante@inyocounty.us mjazevedo@countyofcolusa.org mmoeinaddini@srta.ca.gov mthomas@countyofglenn.net mwoodman@nccn.net oona.smith@hcaog.net programming@sccrtc.org publicworks@sierracounty.ca.gov rbrady@tularecog.org rcarter@pctpa.net sacsim@sacog.org slocog@slocog.org spekaj@dow-associates.com ssaad@trinitycounty.org tamera@dnltc.org terri.king@co.kings.ca.us twoodrow@alpinecountyca.gov wdeloria@edctc.org wrush@sbcag.org ziying.ouyang@sandag.org	bsana@sandag.org	niblock@sjcog.org>	mwoodman@nccn.net

Table B. MPO/RTPA Interview Communication Records

MPO/RTPA	Interview Request Sent to	Interview Request Sent on	Reminder Sent on	Response	Scheduled Interview	Interview Attendees
SCAG	HU@scag.ca.gov	Dec 9, 2024		Yes	Dec 17, 2024	Hsi-Hwa Hu
SACOG	kshipley@sacog.org	Dec 9, 2024		Yes	Dec 18, 2024	Kyle Shipley
AMBAG	bpatel@ambag.org	Dec 9, 2024	Dec 13, 2024	Yes	Jan 16, 2025	Bhupendra Patel
MCAG	rui.ma@mcagov.org	Dec 9, 2024		Yes	Dec 20, 2024	Rui Ma
FCOG	khan@fresnocog.org	Dec 9, 2024		Yes	Dec 13, 2024	Kai Han; Santosh Bhattarai
TCAG	rbrady@tularecag.ca.gov	Dec 9, 2024	Dec 13, 2024		Jan 22, 2025	Roberto Brady
KCOG	eflickinger@kerncog.org	Dec 9, 2024	Dec 13, 2024	Yes	Dec 16, 2024	Ed Flickinger
MTC	lzorn@bayareametro.gov	Dec 9, 2024	Dec 13, 2024	Yes	Jan 24, 2025	Lisa Zorn
SRTA	mmoeinaddini@srta.ca.gov	Dec 9, 2024		Yes	Dec 17, 2024	Mehdi Moeinaddini
SANDAG	bhargava.sana@sandag.org	Dec 10, 2024	Dec 13, 2024	Yes	Dec 20, 2024	Bhargava Sana; Cundo Arellano; Ziying Ouyang
DNLTC	tameraleighton@dnltc.org	Dec 10, 2024		Yes	Dec 13, 2024	Tamera Leighton
SJCOG	niblock@sjcog.org	Jan 8, 2025	Jan 14, 2025	Yes	Jan 24, 2025	Ryan Niblock
NCTC	mwoodman@nccn.net	Jan 21, 2025	Feb 11, 2025	Yes	Feb 26, 2025	Mike Woodman; Aron Hoyt
HCAOG, Lake APC	Lisa.Buglewicz@dot.ca.gov	Dec 10, 2024	Dec 13, 2024	No	NA	NA

Table C. Project Interview Communication Records

		Yolo-80 Managed Lane Project	SR-99 Tulare Widening Project	I-5 Managed Lanes Project	I-205 Interchange Tracy Project
Contact Information	Caltrans Project Manager	Gurtej Bhattal, gurtej.bhattal@dot.ca.gov	Michael Dennison, michael.dennison@dot.ca.gov	Janilee Jablonski, janilee.jablonski@dot.ca.gov	Dina EL-Nakhal, Dina.EL-Nakhal@dot.ca.gov
	Other Contacts		Senior Environmental Scientist: Javier Almaguer, javier.almaguer@dot.ca.gov	Senior Environmental Scientist: Smita Deshpande, smita.deshpande@dot.ca.gov	Caltrans Oversight Senior Environmental Manager: Jennifer Lugo, jennifer.lugo@dot.ca.gov
Project Info Collection	Project Documentation Request Sent	Nov 5, 2024	Nov 5, 2024	Nov 5, 2024	Nov 5, 2024
	Request Received	Nov 6, 2024	Nov 5, 2024	Nov 8, 2024	Nov 6, 2024
	Files Received	Nov 6, 2024	Nov 6, 2024	Nov 8, 2024	Nov 8, 2024
	Files Sent By	Gurtej Bhattal, gurtej.bhattal@dot.ca.gov	Senior Environmental Scientist: Javier Almaguer, javier.almaguer@dot.ca.gov	Senior Environmental Scientist: Smita Deshpande, smita.deshpande@dot.ca.gov	Caltrans Oversight Senior Environmental Manager: Jennifer Lugo, jennifer.lugo@dot.ca.gov
Project Interview	Interview Request Sent	Feb 11, 2025	Feb 11, 2025	Feb 11, 2025	Feb 11, 2025
	Request Follow-Up	Feb 21, 2025	Feb 17, 2025	Feb 17, 2025	Feb 17, 2025
	Interview Scheduled	Feb 27, 2025 2:00-3:00 PM (Cancelled)	Feb 24, 2025 3:00-4:00 PM	Feb 28, 2025 10:00-11:00 AM	March 12, 2025 2:30 -3:30 PM
	Interview Attendees	NA	Michael Dennison Javier Almaguer Abi-Rached, Emad Eric Olson	Janilee Jablonski Smita Deshpande Jose Hernandez Alben Phung Loren Bloomberg Jeffrey Fromhertz Neha Rathi	Dina El-Nakhal Jennifer Lugo Eric Chin Jaime Quesada Sang Huynh Serafin Herrera Koua Yang Thomas Dumas

APPENDIX C

Model Assessment Checklist

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	**MTC TM 1.5.2**	**SCAG ABM**	**SJCOG TCM VMIP 2.0**	**TCAG MIP 2.0**	**SANDAG ABM2+**
Model Documentation									
Complete Model Documentation is available	Model Development Report	Model provides a development report that includes methodology, validation reports, and model performance. For CEQA and planning use, this report helps ensure transparency, replicability, and appropriate use of the model.	High	Yes - Model development technical memos and reports are publicly available. https://www.sacog.org/planning/data-resource-center/travel-demand-model/travel-model-documentation	Yes - Model development technical memos and reports are publicly available. https://github.com/BayAreaMetro/modeling-website/wiki/TravelModel	Yes - Model development technical memos and reports are publicly available. https://scag.ca.gov/transportation-models	Yes - Model development reports are available per request.	Yes - Model development technical memos and reports are publicly available. https://tularecog.org/tcag/data-gis-modeling/regional-travel-model-documentation/	Yes - Model development technical memos and reports are publicly available. https://github.com/SANDAG/ABM/wiki/Reports-and-Documents
	Model Installation Guide	A publicly accessible model installation guide ensures that users can run the model and replicate results. This should include software, versions, and computing environment requirement as well as proper guidance on how to install them.	Moderate	Yes	Yes	No - No separate document for model installation guide that is publicly available	No - No separate document for model installation guide, no available sources for installation guide	Yes - No separate document for model installation guide, but the model user guide includes a section for installation	Yes - No separate document for model installation guide, briefly talked about installation of model components in user guide
	Model User Guide	A model user guide provides guidance on how to apply the model including how to update necessary modeling components. A well-documented user guide would provide guidance on all aspects of the model including how to edit population synthesis, special generator, external workers, commercial vehicle trips, etc.	High	Incomplete - Does not include guidance on all aspects of how to edit and apply the model	Incomplete - Does not include guidance on all aspects of how to edit and apply the model	Incomplete - Does not include guidance on all aspects of how to edit and apply the model	No - No available model user guide as a separate document	Incomplete - Does not include guidance on all aspects of how to edit and apply the model	Incomplete - Does not include guidance on all aspects of how to edit and apply the model
	Guidance on project-level application	A model user guide on project-level application provides guidance on sub-area calibration/validation, how to change model inputs and parameters, and how to prepare and evaluate model outputs.	High	No - No project-level application guidance available	No - No project-level application guidance available	No - No project-level application guidance available	No - No project-level application guidance available	Incomplete - model documentation recommends local area model validation and calibration for project application and specifies that refinements may be needed before using the model for project applications. However it does not discuss project's effect on VMT and induced VMT	No - No project-level application guidance available
	Data Dictionary	Provides clarity on the data variables, definitions, and relationships used in the TDM, which aids users in accurately interpreting the data, ensuring consistent application and enhancing the overall reliability of analyses and outcomes.	High	Yes	Yes	Yes	Yes	Yes	Yes
All model files are actively maintained, organized, and are available	Input files	Provides the required model input variables in the appropriate format to execute the model.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Output files	Allows users to replicate results and compare findings, fostering trust in the model's stability.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Intermediate files	Allow users to follow the data transformation throughout the modeling process.	High	Yes	Incomplete - Intermediate files are not publicly available	Yes	Yes	Yes	Yes
All Model files are available for scenario years	Base Year	Base year refers to the year in which current travel patterns, population data, land use, and other relevant factors are measured or observed. It serves as the starting point for forecasting future travel demand and is used to calibrate the model by comparing projected data to actual observed data.	High	Yes (2016)	Yes (2015)	Yes (2019)	Yes (2016)	Yes (2015)	Yes (2016)
	Interim Year	Interim year refers to a year or set of years (both land use and network) between the base year and the horizon year. This is especially important for Caltrans projects where an opening year scenario is needed.	Moderate	Incomplete - Only limited interim year data is available. Interim year does not have detailed land use and demographic input that is calibrated to the year.	Incomplete - Only limited interim year data is available.	Incomplete - Only limited interim year data is available.	Incomplete - Only limited interim year data is available.	Incomplete - Only limited interim year data is available.	Incomplete - Only limited interim year data is available.

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
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Model Documentation									
All Model files are available for scenario years	Horizon Year	The horizon year refers to the target year for which future travel patterns and demand are projected, typically based on RTP or MTP/SCS.	High	Yes	Yes	Yes	Yes	Yes	Yes
Model Year Alignment									
Model base year is within the past 5 years		Establishes confidence that the model's base year is a relevant foundation for assessing changes under future conditions. Base year needs to be more current when substantial disruptions like COVID-19 occur.	High	No - Model base year is 2016 and does not include any adjustments to reflect changes by COVID-19.	No - The model base year is 2015, and as such does not reflect post-COVID conditions.	No - The model base year is 2019, and as such does not reflect post-COVID conditions.	No - The model base year is 2016, and as such does not reflect post-COVID conditions.	No - The model base year is 2015, and as such does not reflect post-COVID conditions.	No - The model base year is 2016, and as such does not reflect post-COVID conditions.
Model horizon year aligns with the latest published MPO RTP/SCS		MPOs design models to review their RTP/SCS. Horizon year should reflect "reasonably foreseeable" land use growth and network changes based on financial constraints.	High	Yes	Yes	Yes	Yes	Yes	Yes
Completed calibration and validation within the past 5 years	Calibration	Model's parameters and algorithms were adjusted within the last 5 years to match observed travel behavior and traffic conditions.	High	No - SACSIM19 base year 2016 model was calibrated using travel data including 2016 five-year ACS data, the 2000 SACOG Household Travel Survey, the 2018 SACOG Household Travel Survey, 2013 Connect Card Survey by SACOG, historical traffic count data for 2005, 2008, and 2012, etc. All calibration was performed on regional level and no project-level calibration was completed.	Incomplete - Calibration and validation report was completed in November 2021 and is publicly available. The static validation does not include all industry standard tests, most notably vehicle trip length and VMT checks. The report compares model outputs and observed data, but does not use industry standard thresholds to determine if the model passes validation checks.	No - Calibration was performed based on observed travel behavior and traffic conditions in 2019. The calibration targets were derived based on data from 2012 CHTS. All calibration was performed on regional or county level and no project-level calibration was completed.	No - Calibration was performed based on observed travel behavior and traffic conditions of historical SJCOG data, 2012 CHTS, and 2018 San San Joaquin County Congestion Management Program Counts. No detailed model calibration descriptions or results are available.	No - Calibration was performed based on observed travel behavior and traffic conditions from 2012 CHTS. All calibration was performed on regional or county level and no project-level calibration was completed. The model documentation mentions that local area model validation and calibration is recommended for project application.	No - The model update in 2018 provides updates on data used to re-calibrate and validate the revised model and the process and results of model calibration and validation. The data used is prior to year 2016. All calibration was performed on regional or county level and no project-level calibration was completed.
	Static Validation (Daily)	Model's outputs were compared against observed data, such as traffic counts, trip lengths, and transit ridership within the last 5 years. AM and PM peak hour/period statistical validation tests were done.	High	Incomplete - As of 2025, SACSIM19 base year 2016 model was validated when the model was released (2020). No updated model validation has been completed within the last 5 years. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - The static validation does not include all industry standard tests, most notably vehicle trip length and VMT checks. The report compares model outputs and observed data, but does not use industry standard thresholds to determine if the model passes validation checks. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - The static validation was compared to observed travel behavior and traffic conditions in 2019. The validation was evaluated on a regional level with no tests done for local or project level.	Incomplete - The static validation was compared to observed travel behavior and traffic conditions in 2012 CHTS and 2018 counts. The validation was evaluated on a regional level with no tests done for local or project level.	No - The static validation was compared to observed travel behavior and traffic conditions from 2012 CHTS. The model does not pass all of the static validation tests. All validation was evaluated on a regional level with no tests done for local or project level. The model documentation recommends local area model validation and calibration for project application.	Incomplete - The static validation was compared to observed travel behavior and traffic conditions prior to year 2016. The validation was evaluated on a regional level with no tests done for local or project level.
	Static Validation (AM and PM Peak)		High	Incomplete - No peak hour counts were processed or utilized for SACSIM19. The three hour peak AM and PM periods demand was derived from Caltrans household travel survey and 2018 SACOG household travel survey. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - AM and PM peak validation on highway assignment were conducted for model year 2015. However, the validation results were evaluated on regional level only.	Incomplete - Static validation results are only available for daily level. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - Static validation results are only available for daily level. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - Static validation results are only available for daily level. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - Static validation results are only available for daily level. The validation was performed on regional level and no project-level calibration was completed.

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	**MTC TM 1.5.2**	**SCAG ABM**	**SJCOG TCM VMIP 2.0**	**TCAG MIP 2.0**	**SANDAG ABM2+**
Model Year Alignment									
Completed calibration and validation within the past 5 years	Dynamic Validation/Sensitivity Tests	Model's ability to respond in the correct direction and magnitude to changes in inputs, such as land use, network, travel cost, or value of time were tested within the last 5 years.	Moderate	Incomplete - Experimental sensitivity tests were performed when the model was released, using model inputs from year 2008 and DAYSIM submodule of SACSIM19. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - No dynamic validation/sensitivity tests have been performed within the last 5 years. Sensitivity tests were performed for an earlier version of the model in 2012 on regional level.	Incomplete - The sensitivity testing report published in 2020 includes the details of sensitivity tests of the model. The validation was performed on regional level and no project-level calibration was completed.	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - Experimental sensitivity tests were performed when the model was released. The validation was performed on regional level and no project-level calibration was completed.	Incomplete - The sensitivity testing report published in 2020 includes the details of sensitivity tests of the model. The validation was performed on regional level and no project-level calibration was completed.
Dynamic/sensitivity tests were performed (regional and project-level)	Demographic Changes	Tested if models are sensitive to changes in population characteristics	Moderate	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - Sensitivity test was performed on regional level only
	Land use changes	Tested if model is sensitive to changes in the amount, mix, or pattern of development, such as new housing or increased density.	Moderate	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - Sensitivity test was performed on regional level only
	Network Changes	Tested if model is sensitive to network additions, subtractions, or modifications.	Moderate	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - Sensitivity test was performed on regional level only
	Transit Changes	Tested if model is sensitive to changes in the transit network or service.	Moderate	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	Incomplete - Sensitivity test was performed on regional level only	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - Sensitivity test was performed on regional level only
	Model Parameters (Number of Iterations, Relative Gaps, Random Seed etc.)	Tested if model feedback processes especially for distribution and assignment and each an equilibrium convergence that is stable.	Moderate	Incomplete - The model was tested to assess random variation however only regional level test results are evaluated.	Incomplete - The model was tested to assess random variation however only regional level test results are evaluated.	Incomplete - The model was tested to assess random variation however only regional level test results are evaluated.	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - The model was tested to assess random variation however only regional level test results are evaluated.
Model Performance against Available Guidance									
Model results can be replicated		Replicability ensures transparency, credibility, and trust in travel demand model results, especially for CEQA compliance.	High	Yes	Incomplete -Instructions from MTC were used to run the model but the outputs are slightly different from the provided results	Yes	Yes	Yes	Yes
Documentation shows the model passes Static Validation		Static validation tests performed include those specified in 2024 CTC and FHWA guidelines and the model passes the tests. All model major highways are included in the tests.	High	Incomplete - the static validation was evaluated on a regional level with no tests done for local or project level.	Incomplete - the static validation was evaluated on a regional level with no tests done for local or project level.	Incomplete - the static validation was evaluated on a regional level with no tests done for local or project level.	Incomplete - the static validation was evaluated on a regional level with no tests done for local or project level.	Incomplete - the static validation was evaluated on a regional level with no tests done for local or project level.	Incomplete - the static validation was evaluated on a regional level with no tests done for local or project level.
Documentation shows the model is sensitive to dynamic changes	Demographic Changes	Dynamic tests verify that the model contains an appropriate level of sensitivity related to the types of transportation network or land use changes associated with the project. Dynamic validation/sensitivity tests include these validation tests and the model responds appropriately to the input changes.	High	Incomplete - Sensitivity test was performed to evaluate how model react to household income change. The model results are mostly within the observed range of elasticities, however, there are a few not in the range. No analysis were done at project level.	Incomplete - Sensitivity test was performed to evaluate some demographic parameters. The model results are mostly within the observed range of elasticities, however, there are a few not in the range. No analysis were done at project level.	Incomplete - Sensitivity tests were conducted to evaluate effects of some demographic parameters. However, the results were not compared to industry standard thresholds or range check to determine if the model is sensitive to the input change or not.	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - The model sensitivity testing report shows that ABM2+ is sensitive to household income and regional employment. However, the sensitivity tests were performed on regional level only.

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	**MTC TM 1.5.2**	**SCAG ABM**	**SJCOG TCM VMIP 2.0**	**TCAG MIP 2.0**	**SANDAG ABM2+**
Model Performance against Available Guidance									
Documentation shows the model is sensitive to dynamic changes	Land use changes	Dynamic tests verify that the model contains an appropriate level of sensitivity related to the types of transportation network or land use changes associated with the project. Dynamic validation/sensitivity tests include these validation tests and the model responds appropriately to the input changes.	High	Incomplete - Sensitivity tests were conducted to evaluate effects of regionwide land use changes. No tests were done at project level. The results were not compared to industry standard thresholds or range check	Incomplete - Sensitivity tests were conducted to evaluate effects of regionwide land use changes. No tests were done at project level. The results were not compared to industry standard thresholds or range check	Incomplete - Sensitivity tests were conducted to evaluate effects of regionwide land use changes. No tests were done at project level. The results were not compared to industry standard thresholds or range check	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - Sensitivity tests were conducted to evaluate effects of regionwide land use changes. No tests were done at project level. The results were not compared to industry standard thresholds or range check
	Roadway Network Changes		High	Incomplete - Sensitivity test was performed to evaluate how model react to highway capacity change. The model results are mostly within the observed range of elasticities, however, there are a few not in the range.	Incomplete - No dynamic validation/sensitivity tests have been performed within the last 5 years. Sensitivity tests were performed for an earlier version of the model in 2012.	Incomplete - Sensitivity tests were conducted to evaluate effects of various inputs in the Model Sensitivity Test Report published in 2020. However, the results were not compared to industry standard thresholds or range check to determine if the model is sensitive to the input change or not.	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - The model sensitivity testing report shows that ABM2+ is sensitive to managed lane/toll price andd reflects to mobility factors such as TNC cost, micromobility speed, etc. However, the sensitivity tests were performed on regional level only.
	Transit Changes		Moderate	Incomplete - Sensitivity test was performed to evaluate how model react to transit fares change. The model results are mostly within the observed range of elasticities, however, there are a few not in the range.	Incomplete - No dynamic validation/sensitivity tests have been performed within the last 5 years. Sensitivity tests were performed for an earlier version of the model in 2012.	Incomplete - Sensitivity tests were conducted to evaluate effects of various inputs in the Model Sensitivity Test Report published in 2020. However, the results were not compared to industry standard thresholds or range check to determine if the model is sensitive to the input change or not.	No - Model documentation does not provide details about dynamic validation or sensitivity tests.	No - no details about the specific sensitivity tests are provided in model documentation.	Incomplete - The model sensitivity testing report shows that ABM2+ is sensitive to transit frequency and transit fares. However, the sensitivity tests were performed on regional level only.
Model can be used to produce different types and scales of VMT	Project-generated VMT	Travel demand and VMT directly associated with a land use project can be isolated	High	Yes	Yes	Yes	Yes	Yes	Yes
	Project effect on VMT	Model-wide VMT with and without the project can be estimated	High	Yes	Yes	Yes	Yes	Yes	Yes
	Total VMT	All passenger and commercial vehicle VMT on a model's network or generated by its land use, population, or employment inputs.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Household Generated VMT	Household generated VMT refers to VMT generated by household residents including non-home-based trips. This is the preferred metric for non-residential land uses.	High	Yes	Yes	Yes	N/A	N/A	Yes
	Home-based VMT	Home-based VMT is VMT associated with trips starting or ending at home, regardless of trip purpose or destination. This captures trips that start at a residence, which is essential for understanding the travel demand by residential locations and trip purposes.	Moderate	Yes	Yes	Yes	Yes	Yes	Yes
	Home-based Work VMT	Home-based work VMT is a subset of home-based VMT, representing trips specifically between home and workplace locations.	Moderate	Yes	Yes	Yes	Yes	Yes	Yes
	Work-Tour VMT	Work-Tour VMT includes total VMT for a complete work-related tour, starting and ending at workplace, including intermediate stops made during the trip. This is the preferred metric for non-residential land uses.	Moderate	Yes	Yes	Yes	N/A	N/A	Yes

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
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Model Performance against Available Guidance									
Model can be used to generate VMT that includes trip length beyond model or political boundaries.		CARB and OPR guidance stresses the importance of capturing full trip lengths, including portions outside the modeled region when estimating VMT for CEQA purposes. Truncating VMT at the boundary can underestimate total travel, especially for regionally significant or interregional projects.	Moderate	Yes - SACSIM19 provides off-model adjustments to capture the trip length beyond the model boundary.	No - the model only captures trip length within model boundary.	No - the model only captures trip length within model boundary.	Incomplete - model has an adjustment to trip length beyond boundary, but has not been updated for long time. And the reasonableness of the adjustments need to be further evaluated.	No - the model only captures trip length within model boundary.	Yes
Model can be used to analyze short-term and long-term induced travel effects of a roadway capacity project	Model documentation discusses induced VMT	Model documentation explicitly discusses induced VMT.	High	Yes	No	No	No	No	No
	Feedback processes for short-term induced vehicle travel effects	Model includes feedback processes where changes in congested travel times influence the forecasts of trip generation (activities), trip distribution (activity type and location), mode choice, and assignment. Work and school location travel should remain fixed between no build and build model runs for this purpose.	High	Incomplete - model only forecasts short-term change of trip distribution and mode choice. No changes in trip generation. Not validated at local level	Incomplete - model only forecasts short-term change of trip distribution and mode choice. No changes in trip generation. Not validated at local level	Incomplete - model only forecasts short-term change of trip distribution and mode choice. No changes in trip generation. Not validated at local level	Incomplete - model only forecasts short-term change of trip distribution and mode choice. No changes in trip generation. Not validated at local level	Incomplete - model only forecasts short-term change of trip distribution and mode choice. No changes in trip generation. Not validated at local level	Incomplete - model only forecasts short-term change of trip distribution and mode choice. No changes in trip generation. Not validated at local level
	Feedback processes for long-term induced vehicle travel effects	Model includes feedback processes that influence long-term land use growth allocations and trip generation. Work and school location travel may change between no build and build model runs for this purpose.	Moderate	No - model does not include long-term induced vehicle travel assessment	No - model does not include long-term induced vehicle travel assessment	No - model does not include long-term induced vehicle travel assessment	No - model does not include long-term induced vehicle travel assessment	No - model does not include long-term induced vehicle travel assessment	No - model does not include long-term induced vehicle travel assessment
	Accounts for temporal Variation	Model accounts for shifts in time-of-day travel patterns due to congestion, which can impact peak period and peak hour design volumes.	High	No	No	No	No	No	No
	Includes dynamic traffic assignment (DTA)	Model includes DTA which is necessary to reasonably forecast changes in travel times if congestion extends beyond one peak hour.	Moderate	No	No	No	No	No	No
Modeling Detail									
Model has adequate network detail	Roadway network	Collector and above functional class facilities are coded correctly in the model. This ensures the vehicle movement, traffic flow, and congestion patterns can be accurately modeled and forecasted.	High	Yes	Yes	Yes	Yes	Yes	Yes
	Transit network	All transit lines are coded in the model. This allows the model to better capture mode share and changes in travel metrics such as VMT.	High	Yes	Yes	Yes	Incomplete	Yes	Yes
	Active Transportation network	Model accounts for non-motorized travel modes, such as walking and cycling. All roads with bike lanes and walk-bike only routes are represented in the model.	High	Incomplete - model network has most types of walk-bike facilities but does not fully capture the latest bike trail network.	No - although the mode share accounts for bike mode, there are no bike facility specified on the network	Incomplete - model accounts for bike lane density but detailed bike network is missing	Incomplete - the model has bike but it does not fully capture the latest bike trail network.	Incomplete - the model has bike but it does not fully capture the latest bike trail network.	No - although the mode share accounts for bike mode, there are no bike facility specified on the network
	Tolling facilities	Model includes tolling facilities that appropriately evaluate the effects of tolls on travel behavior and revenue generation.		Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ aresubject per I-80 study.	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	No - Model documentation does not mention toll facilities	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.
	Transportation Analysis Zone (TAZ) Structure	Model TAZ density is appropriately distributed in the model to reflect the density of traffic loading access points throughout the model boundary.	High	Incomplete - model has limited TAZ details outside the core urban area	Incomplete - model has limited TAZ details outside the core urban area	Incomplete - model has limited TAZ details outside the core urban area	Incomplete - model has limited TAZ details outside the core urban area	Incomplete - model has limited TAZ details outside the core urban area	Incomplete - model has limited TAZ details outside the core urban area

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	**MTC TM 1.5.2**	**SCAG ABM**	**SJCOG TCM VMIP 2.0**	**TCAG MIP 2.0**	**SANDAG ABM2+**
Modeling Detail									
Model scenarios reflect recent travel behavior trends		Model incorporates recent travel behavior trends, especially pre- and post-COVID differences, capture shifts in patterns such as remote work, changes in commuting patterns, etc.	High	No	Incomplete - The Calibration & Validation Report released in May 2024 is a supplement to the 1.5.2 report to update the essential COVID-related travel behavior changes.	No	No	No	No
Highway assignment parameters adequate to minimize model noise		Model's settings ensure stable results; model converges with minimal noise	High	Incomplete - Inadequate details on the available guidance on dealing with model noise in documentation.	Incomplete - Inadequate details on the available guidance on dealing with model noise in documentation. No mention of multiple runs	Incomplete - Inadequate details on the available guidance on dealing with model noise in documentation. No mention of multiple runs	No - No available guidance on dealing with model noise in documentation.	No - No available guidance on dealing with model noise in documentation.	Incomplete - Inadequate details on the available guidance on dealing with model noise in documentation. No mention of multiple runs
Model Sub-Modules									
Sub-module files and associated user guides are available	Commercial vehicle model	Model includes freight travel demand and supply that appropriately reflect freight travel and delivery activities which is essential for roadway congestion metrics and infrastructure needs	High	Incomplete - The model includes the submodule but the submodule does not specify how to adjust to the changes on facilities.	Incomplete - The model includes the a static submodule that does not adjust to the changes in land use or facility	Incomplete - The model includes the submodule but does not specify how to adjust to the changes on facilities.	Incomplete - The model includes the a static submodule that does not adjust to the changes in land use or facility	Incomplete - The model includes the a static submodule that does not adjust to the changes in land use or facility	Incomplete - The model includes the submodule but does not specify how to adjust to the changes on facilities.
	Population Synthesizer/Land Use model	Model simulates demographic characteristics and household attributes, used to estimate travel behavior and demand. Model includes necessary tools and inputs required to calculate synthetic population.	Moderate	Yes	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	N/A - Trip-based model does not have population synthesizer submodule.	N/A - Trip-based model does not have population synthesizer submodule.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.
	Airport travel model	Model includes trips associated with air travel, including passengers, goods, and employee movements to and from airports.	Moderate	Yes	Yes	Yes	No - The model does not have an airport travel model	No - The model does not have an airport travel model	Yes
	Visitor travel model	Model includes dynamic sub-module to capture travel behavior of tourists and non-residents, whose trip-making decisions differ from residents.	Moderate	No - Model does not capture visitor travel behaviors on adjustable demand and supply level.	No - Model does not capture visitor travel behaviors on adjustable demand and supply level.	No - Model does not capture visitor travel behaviors on adjustable demand and supply level.	No - Model does not capture visitor travel behaviors on adjustable demand and supply level.	No - Model does not capture visitor travel behaviors on adjustable demand and supply level.	No - Model does not capture visitor travel behaviors on adjustable demand and supply level.
	Internal/external travel model	Model includes a sub-module that captures trips that begin and end outside the study area.	High	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule has limited ability to adjust demand and supply according to changes to facilities.	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule does not have ability to adjust demand and supply according to changes to facilities.	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule does not have ability to adjust demand and supply according to changes to facilities.	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule does not have ability to adjust demand and supply according to changes to facilities.	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule does not have ability to adjust demand and supply according to changes to facilities.	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule does not have ability to adjust demand and supply according to changes to facilities.
	Toll model	Model includes a sub-module that evaluates the impact of toll roads on travel behavior and route choice	High	Yes	Yes	Yes	No	Yes	Yes
Sub-modules are dynamic (changes in land use and network will change these model output)	Commercial vehicle model	Modul adjusts based on changes in road infrastructure (e.g., new highways or tolls) and shifts in land use pattern	High	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.
	Population Synthesizer/Land Use model	Modul dynamically updates population or land use model based on input changes	Moderate	Incomplete - The model includes the submodule but the submodule has limited ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.	N/A - Trip-based model does not have population synthesizer submodule.	N/A - Trip-based model does not have population synthesizer submodule.	Incomplete - The model includes the submodule but the submodule does not have ability to adjust to the changes on facilities.
	Airport travel model	Changes in airport capacity, expansion projects, or regional infrastructure improvements will dynamically update forecasts.	Moderate	No	No	No	No	No	No
	Visitor travel model	Land use and network changes will alter ground travel patterns of visitors	Moderate	No	No	No	No	No	No

Assessment Criteria and Metric		Description	Priority	Assessment Findings					
				SACOG SACSIM19	**MTC TM 1.5.2**	**SCAG ABM**	**SJCOG TCM VMIP 2.0**	**TCAG MIP 2.0**	**SANDAG ABM2+**
Model Sub-Modules									
Sub-modules are dynamic (changes in land use and network will change these model output)	Internal/external travel model	Regional land use, road networks, or external connectivity (e.g., new bridges or regional rail connections) dynamically change external travel demand.	High	Incomplete - Model has IXXI inputs to represent internal/external travel patterns. However, the submodule has limited ability to adjust demand and supply according to changes to facilities.	No - Model has static IXXI trip input to represent internal/external travel patterns, yet does not have ability to reflect to dynamic demand and supply changes	No - Model has static IXXI trip input to represent internal/external travel patterns, yet does not have ability to reflect to dynamic demand and supply changes	No - Model has static IXXI trip input to represent internal/external travel patterns, yet does not have ability to reflect to dynamic demand and supply changes	No - Model has static IXXI trip input to represent internal/external travel patterns, yet does not have ability to reflect to dynamic demand and supply changes	No - Model has static IXXI trip input to represent internal/external travel patterns, yet does not have ability to reflect to dynamic demand and supply changes
	Toll model	Toll rates and toll booth placement changes, as well as network modifications (e.g., new toll roads or adjusted routes), will impact on traveler route choices and overall demand.		Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	No - Model documentation does not mention toll facilities	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.	Incomplete - the model assumes the full driver population is subject to toll/time savings op, yet TRB research shows only about ⅔ are subject per I-80 study.