Travel Forecasting Guidance: Survey of Practice

Requested by
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Executive Summary

Background

Caltrans District 11 is taking the lead working in coordination with several Caltrans districts and Caltrans headquarters to gather information that will inform development of departmentwide travel forecasting guidelines. The last Caltrans travel forecasting guidance, published in November 1992, serves primarily as a manual of how to perform travel demand modeling. The lack of a departmentwide set of standard practices or guidelines for travel forecasting has led to the application of a range of methods and applications applied by Caltrans districts and programs.

To inform Caltrans' development of new travel forecasting guidance, CTC & Associates surveyed two groups of respondents:

- *Other state agencies:* Eight state departments of transportation (DOTs) and four metropolitan planning organizations (MPOs) in large urban areas outside of California known to have experience with travel forecasting.
- *California agencies:* Six MPOs and one regional transportation planning agency that are representative of agencies serving large urban areas and the more rural areas of California.

Survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

Summary of Findings

Below is a summary of findings in two topic areas:

- Survey of practice.
- Related research and resources.

Survey of Practice

Seven agencies responded to the survey, including state DOTs in Florida, Texas and Virginia, and two MPOs in other states—Atlanta Regional Commission (Georgia) and Puget Sound Regional Council (Washington). Two California agencies responded—Fresno Council of Governments (COG) and Sacramento Area Council of Governments (SACOG).

Key findings from the case studies that begin on page 12 are highlighted below in nine topic areas:

- Description of agency models.
- Updating the model and related guidance.
- Ensuring relevance to current conditions.
- Key concepts.
- Addressing policy- and project-level questions.
- Addressing induced vehicle travel demand.

- Relationship to statutory requirements.
- Best practices.
- Impact on local development-intergovernmental review (California agencies only).

Further details are provided in each respondent's case study in the **Detailed Findings** section of this report.

Description of Agency Models

The table below provides general information about the models and modeling practices of the seven agencies responding to the survey.

Description of Agency Models

State	Agency	Start of Forecasting/ Modeling	Model Type				Funding Source for Model Development
			Trip-Based	Activity-Based	Statewide	Regional	
California	**Fresno COG**	1986	X	X		X	Combination of local, state and federal funds.
	SACOG	1980s		X		X	Staff time largely funded with federal Metropolitan Planning Funds (PL funds).
Florida	**Florida DOT**	Mid-1980s	X		X		Combination of local, state and federal funds.
Georgia	**Atlanta Regional Commission**	1980s		X		X	Combination of local, state and federal funds.
Texas	**Texas DOT**	Late 1950s/early 1960s	X		X		Federal funds.
Virginia	**Virginia DOT**	1970s	X		X	X	Federal funds.
Washington	**Puget Sound Regional Council**	More than 30 years ago	X	X		X	Combination of local, state and federal funds.

The table below identifies how respondents described the typical application of agency models from among these options:

- Provide future traffic data for capacity analysis.
- Provide future data for air quality analysis.
- Conduct corridor analysis for design alternative assessments in future years.
- Develop impact assessments of proposed projects (land use) on the existing freeway system in future years.
- Develop impact assessments of the conversion of high-occupancy vehicle (HOV) to high-occupancy toll (HOT) lanes on the local freeway system in future years.

Model Application

State	Agency	Future Traffic Data for Capacity Analysis	Future Data for Air Quality Analysis	Corridor Analysis for Design Alternative Assessment	Impact Assessment of Proposed Projects on Land Use	Impact Assessment of HOV to HOT Lane
California	**Fresno COG**	X	X	X	X	
	SACOG	X	X	X		X
Florida	**Florida DOT**	X	X	X	X	
Georgia	**Atlanta Regional Commission**	X	X	X	X	X
Texas	**Texas DOT**		X	X		
Virginia	**Virginia DOT**	X	X	X		X
Washington	**Puget Sound Regional Council**	X	X	X	X	X

Other Model Applications

Respondents also reported on other model applications:

- In Florida, the Florida Statewide Model is applied for the analysis of freight and commodity movements, intelligent transportation system evaluations, emergency evacuations and toll modeling.
- In Texas, agency management specifies that travel demand models are not used for project-level analysis. Models are used instead to inform the analysis, usually through growth rate and origin-destination patterns.
- SACOG's application of its travel demand model is focused on region-level system analysis and, to a lesser extent, project phasing analysis. The agency is conducting its first modeling effort on HOT lanes and other price-managed facilities for the ongoing 2020 Metropolitan Transportation Plan/Sustainable Communities Strategy update.

Updating the Model and Related Guidance

Florida DOT's Florida Model Task Force is one of the more notable agency practices for updating models and the related guidance. This umbrella organization establishes policy directions and procedural guidelines for transportation modeling in Florida using the Florida Standard Urban Transportation Modeling Structure, the standard model used by Florida's urban areas for travel demand forecasting. Atlanta Regional Commission also employs an oversight body. A model users group meets quarterly and engages in a consultation process with major regional planning partners and stakeholders, local modelers and the state DOT.

Other respondents described how their models and guidance are updated:

- The Fresno COG respondent described recently completed modeling improvements conducted in connection with the second phase of the San Joaquin Valley Model Improvement Plan. Modeling improvements were made to update each Valley MPO model to be more sensitive to smart growth.
- Virginia DOT is currently developing an overall forecasting guidance document that is expected to be published later in 2019, perhaps by the end of May. The respondent recommended reviewing the agency's previously issued guidance, cited on page 20, which will be referenced in the upcoming traffic forecasting guidance.

Ensuring Relevance to Current Conditions

Several responding agencies work with or act as oversight bodies to ensure agency models and guidance remain relevant. While Florida DOT's Florida Model Task Force meets annually, technical committees are at work throughout the year addressing technical issues associated with data and geographic information system (GIS), freight, model advancement and transit. Atlanta Regional Commission oversees all modeling work that employs the agency's regional activity-based travel demand model, meeting with project sponsors and consultants requesting and applying the model. Puget Sound Regional Council also engages with stakeholders that include modelers inside and outside the agency.

Key Concepts

Respondents were asked to describe the key concepts that constitute the basis of their agencies' travel forecasting guidance. Rather than describing these key concepts, the Fresno COG respondent reported on the development of an activity-based model that supplements the agency's current trip-based, four-step travel demand model. The new model is expected to address increased interest in measuring impacts from compact and mixed-use development, active transportation, transit and pricing. SACOG relies on guidance provided by the California Transportation Commission and Federal Highway Administration (FHWA) and has not developed independent guidance.

The table below highlights other key findings.

Basis for Respondents' Travel Forecasting Guidance

State	Agency	Key Concept
Georgia	**Atlanta Regional Commission**	Ensure consistency with air quality conformity determinations, federal guidance and basic premises relating to model development, calibration and validation.

Basis for Respondents' Travel Forecasting Guidance		
State	**Agency**	**Key Concept**
Texas	**Texas DOT**	Prepare project-level forecasts for feasibility and planning to provide 24-hour-volume annual average daily traffic; develop travel demand models to support long-range planning that provide a baseline for plans and analyses.
Virginia	**Virginia DOT**	Use available information, including traffic history, travel demand modeling and trip rates.
Washington	**Puget Sound Regional Council**	Add features needed to answer specific questions. For example, the agency is adding a mode to address ridesharing services.

Addressing Policy- and Project-Level Questions

The table below summarizes the policy- and project-level questions respondents' travel forecasting and modeling staff members are asked or required to address in four topic areas: environment, planning, traffic and transportation network. The case studies beginning on page 12 provide information about other topic areas addressed by agency modeling, including new services and technology, tourism and transit.

Policy- and Project-Level Questions Addressed by Modeling and Forecasting		
Category	**Issue**	**Agency**
Environment	Air and noise analysis.	Texas DOT
	Ensuring air quality conformity.	Fresno COG
	Environmental impact studies.	Virginia DOT
	Forecasting greenhouse gas emissions with regard to land use scenarios.	Fresno COG
	Reducing carbon emissions and supporting the agency's role in meeting the state's climate change goals.	SACOG
	Reducing vehicle emissions and achievement of air quality standards.	SACOG
Planning	Cost-effectiveness of transportation project investments.	SACOG
	Developing the agency's long-term regional transportation plan.	Fresno COG
	Developing impact studies.	Virginia DOT
	Performance measures.	Texas DOT
	Phasing of growth.	SACOG
	Phasing of transportation projects.	SACOG
	Project impacts now versus in the future.	SACOG

Policy- and Project-Level Questions Addressed by Modeling and Forecasting		
Category	**Issue**	**Agency**
Planning (continued)	Project scenarios.	Puget Sound Regional Commission
	Scenario planning such as transit-oriented development versus distributed growth.	Puget Sound Regional Commission
	Supporting statewide, freight and rail plans.	Texas DOT
Traffic	Assessing traffic impacts of local developments.	Fresno COG
	Congestion.	Texas DOT
	Emergency evacuations.	Florida DOT
	Hot spot analysis.	Texas DOT
	Interchange justification report/interchange modification report studies.	Virginia DOT
Transportation network	Connectivity.	Texas DOT
	HOV/HOT lanes.	Virginia DOT
	Land use/transportation connection and interactions.	SACOG
	Modal split.	Virginia DOT
	Road pricing.	Puget Sound Regional Commission
	Toll projects, including congestion pricing and managed lanes.	Atlanta Regional Commission
	Trade-offs on roadway system expansion versus operations and maintenance investments.	SACOG

Addressing Induced Vehicle Travel Demand

Respondents were asked to describe how their agency's travel forecasting guidance addresses induced vehicle travel demand. A 2017 *Transportation Research Record* article describes induced vehicle travel as "additional vehicle travel that occurs when the cost is lower; this is a subset of all induced travel." (The 2017 *Transportation Research Record* article is available at http://opr.ca.gov/docs/Closing_the_Induced_Vehicle_Travel_Gap-TRB_Paper-Milam_et_al..pdf.)

Agency responses are summarized below:

- The Florida DOT respondent noted that "[f]undamentally, [induced vehicle travel demand] is a primary objective of most any model." Primarily, Florida DOT models are used to estimate latent demand, or the shift in travel resulting from additional capacity.
- Atlanta Regional Commission accounts for induced demand and induced travel through its fully integrated transport/land use modeling approach.
- Puget Sound Regional Commission runs its demand model with feedback from the network via skims and does not use fixed trip tables. (A travel forecasting glossary

available at https://www.its.uci.edu/~mcnally/tdf-glos.html#s describes “skimming a network” as “the process of systematically identifying network paths (typically) based on the minimization of travel time, distance or generalized cost. The resulting matrices of zone-to-zone impedances are called skims.”)

- Fresno COG’s model addresses induced vehicular travel by providing iterations in model runs where increased roadway capacities will meet the travel demand and provide better level of service, therefore making the particular route more attractive in the trip assignment. In the subsequent iterations, the model will attempt to send more trips to this route in the process of achieving equilibrium.

Relationship to Statutory Requirements

Only one respondent commented on the statutory requirements that impact an agency’s evaluation of development- or project-related impacts. The Atlanta Regional Commission respondent reported an unspecified statutory basis for project-level coding associated with socioeconomic data development requirements.

Best Practices

Among the best practices highlighted by respondents include using oversight bodies like the Florida Model Task Force or a peer review of agency practices, obtaining buy-in from agency partners and private industry conducting business in the state, and ensuring that the latest national guidance is reflected in local practices.

Impact on Local Development-Intergovernmental Review

The surveys provided to both respondent groups were identical with the exception of two additional questions posed to the California agencies. These questions addressed the interaction of travel forecasting with local development-intergovernmental review (LD-IGR), a mandated statewide initiative. LD-IGR is an ongoing effort in California focused primarily on avoiding, eliminating or reducing to insignificance potential adverse impacts of local development on the transportation system.

Neither California respondent described the integration of forecasting into the LD-IGR process or the impact of travel forecasting on reducing vehicle miles traveled or project review for LD-IGR.

Related Research and Resources

National guidance is plentiful in this topic area and includes a traffic analysis tools program developed by FHWA to facilitate the deployment and use of existing tools. Another FHWA web site offers a wealth of publications, webinars and other resources associated with transportation modeling in a wide range of topic areas. Multiple reports published by National Cooperative Highway Research Program (NCHRP) on this topic include a 2017 report that provides guidance on selecting a method for travel forecasting and describes a method selection tool, TFGuide. NCHRP reports published in 2014 and 2012 that address analytical and travel demand forecasting are described as updates to NCHRP guidance issued in the 1980s and 1990s.

Supplementing the publications cited in each case study appearing in the **Survey of Practice** section of this report are manuals, guidelines and other publications that address travel modeling and forecasting practices in 11 states—Arkansas, California, Colorado, Georgia,

Hawaii, Maryland, Minnesota, Nevada, Ohio, Oregon and Wisconsin. Some of this guidance was published quite recently, including the 2018 three-volume draft version of *Ohio Traffic Forecasting Manual*, which will replace a June 2007 Ohio DOT publication. Several publications provide background and specific guidance in addition to a description of agency models and methods.

Gaps in Findings

The surveys, which sought information from a relatively small group of potential respondents, received a limited response. Further attempts to engage with some or all of the agencies not responding to the survey could produce useful guidance. Portions of the survey also received a limited response, specifically related to how statutory requirements are reflected in travel forecasting practices and the impact of travel forecasting on California MPO activities associated with LD-IGR. Follow-up inquiries that target specific areas of interest to Caltrans may lead to valuable additional information.

Two agencies are developing or finalizing travel forecasting guidance. Ohio DOT's 2018 draft publication has yet to be finalized, and Virginia DOT continues work on a forecasting guidance document that is expected to be published later in 2019.

Next Steps

Moving forward, Caltrans could consider:

- Contacting Florida DOT to learn more about the Florida Model Task Force and other agency practices that ensure an ongoing review of forecasting guidance and practices.
- Contacting the California MPO respondents to learn more about new modeling efforts, including:
    - Fresno COG's development of a new activity-based model to supplement the current trip-based, four-step travel demand model. This consultation might also include a discussion of how the agency's current model addresses induced vehicle travel demand.
    - SACOG's first modeling effort on HOT lanes and other price-managed facilities.
- Reviewing in detail the forecasting guidance recently published by Colorado, Florida, Georgia, Ohio, Oregon and Wisconsin DOTs. (Some of these publications refer to NCHRP Report 765 as providing the basis for or a supplement to state guidance; see page 34 for this citation.)
- Checking back with Virginia DOT in late spring 2019 to inquire about completion of the forecasting guidance document now in development.
- Making further attempts to contact nonresponding agencies in a follow-up information gathering effort.

Detailed Findings

Background

Caltrans District 11 is taking the lead working in coordination with several Caltrans districts and Caltrans headquarters to gather information that will inform development of departmentwide travel forecasting guidelines.

The last Caltrans travel forecasting guidance, published in November 1992, serves primarily as a manual of how to perform travel demand modeling. The lack of a departmentwide set of standard practices or guidelines for travel forecasting has led Caltrans districts and programs to use a range of methods and applications. Information is needed to develop new travel forecasting guidelines with clearly defined standards of practice that Caltrans headquarters and district staff members can apply to achieve more consistent and up-to-date travel forecasting practices.

Caltrans is also interested in the application of vehicle miles traveled (VMT) as a metric to evaluate a project's transportation impacts, which is consistent with the requirements of Senate Bill (SB) 743 that implemented a significant change to the California Environmental Quality Act Guidelines for transportation analysis.

Survey of Practice

Survey Approach

Caltrans sought information from two groups of transportation agencies to inform the development of new travel forecasting guidance:

Other state agencies. The state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) in large urban areas listed below are known to have experience with travel forecasting:

- Florida DOT.
- Minnesota DOT.
- North Carolina DOT.
- Ohio DOT.
- Oregon DOT.
- Texas DOT.
- Virginia DOT.
- Washington State DOT.
- Atlanta Regional Commission.
- Metro (Portland, Oregon).
- North Central Texas Council of Governments (COG) (Dallas).
- Puget Sound Regional Council (Seattle).

California agencies. The following MPOs and regional transportation planning agency are representative of agencies serving large urban areas and the more rural areas of California:

- Fresno COG.
- Merced County Association of Governments.
- Metropolitan Transportation Commission.
- Sacramento Area Council of Governments (SACOG).
- San Diego Association of Governments.

- Shasta Regional Transportation Planning Agency.
- Southern California Association of Governments.

To gather the information needed, CTC & Associates distributed an online survey to both groups of respondents. The survey questions provided to both groups were identical, with the exception of two additional questions posed to the California agency respondents. Survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

Summary of Survey Results

Seven agencies responded to the survey:

Other state agencies: State DOTs in Florida, Texas and Virginia; Atlanta Regional Commission (Georgia); and Puget Sound Regional Council (Washington).

California agencies: Fresno COG and SACOG.

Survey results are presented using brief case studies that address the following topic areas:

- Background.
- The agency's model.
- Updating the model and related guidance.
- Elements of the agency's travel forecasting guidance.
- Best practices.
- Related resources.

Note: Each case study includes a discussion of how each agency's travel forecasting guidance addresses induced vehicle travel demand. A 2017 *Transportation Research Record* article (see http://opr.ca.gov/docs/Closing_the_Induced_Vehicle_Travel_Gap-TRB_Paper-Milam_et_al..pdf) describes induced vehicle travel as "additional vehicle travel that occurs when the cost is lower; this is a subset of all induced travel." The 2017 paper used VMT level to measure additional vehicle travel.

Supplementing the survey results are findings from a limited literature search that reviewed recent domestic publications; see **Related Research and Resources** beginning on page 32.

Other State Agencies

The case studies below begin with the three state DOT respondents (Florida, Texas and Virginia) and are followed by case studies for MPOs in Georgia and Washington.

Florida Department of Transportation

Background

The first Florida-based travel demand models were developed in the mid-1980s. Updating the agency's travel demand guidance is a continual process. Some guidance does not require revision as often as others, and the agency has determined that it is more effective to re-evaluate targeted subjects than to conduct broad updates.

Florida Department of Transportation	
The Agency's Model	
Model Description	Modeling developed with the use of local, state and federal funds can produce trip-based and statewide results.
Model Application	• Provide future traffic data for capacity analysis. • Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years. • Develop impact assessments of proposed projects (land use) on the existing freeway system in future years. The statewide model is applied for the analysis of freight and commodity movements, intelligent transportation system evaluations, emergency evacuations and toll modeling.
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	Florida's modeling guidance is primarily established through the Florida Model Task Force. This umbrella organization establishes policy directions and procedural guidelines for transportation modeling in Florida using the Florida Standard Urban Transportation Modeling Structure (FSUTMS), the standard model used by Florida's urban areas for travel demand forecasting. More information about the standard model and model task force appears in **Best Practices** and ***Related Resources*** below.
Ensuring Relevance to Current Conditions	*Annual meetings*. The Florida Model Task Force holds annual, in-person meetings to discuss and debate new modeling applications and techniques. Prior to the annual meeting, technical issues are reviewed by four topic-specific committees (see below).

Florida Department of Transportation	
Updating the Model and Related Guidance	
Ensuring Relevance to Current Conditions (continued)	*Technical committees*. Four technical committees serve the task force: • Data/GIS (geographic information system). • Freight. • Model advancement. • Transit. Subcommittees are established for highly focused topics as needs arise. Committees and subcommittees meet throughout the year in preparation for the annual meeting. See http://www.fsutmsonline.net/index.php/model_task_f/model_task_f/ for more information about the task force.
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	Standardize the modeling process, including software, applications, procedures, data organization, file formats and training.
Policy- and Project-Level Questions	Current policy-level questions include "disruptive services" such as transportation network companies (TNCs), automated/connected vehicles, freight economics, tourism and emergency evacuations. (TNCs are defined by Federal Highway Administration (FHWA) as "[r]idesourcing services [that] provide prearranged and on-demand transportation services for compensation.")
Addressing Induced Vehicle Travel Demand	The respondent noted that "[f]undamentally, [induced vehicle travel demand] is a primary objective of most any model." Primarily, Florida DOT models are used to estimate latent demand, or the shift in travel resulting from additional capacity. A recently released recommended practice and guidance document estimates latent and induced demand using a multiresolution analysis process. See ***Related Resources*** below for more information.
Relationship to Statutory Requirements	While the respondent indicated that the DOT's travel forecasting guidance does not specifically address statutory requirements, requirements for development and project-related evaluations are directed through department policy guidance. The authority for that guidance is provided for in state statute (Chapter 335, State Highway System, Florida Statutes).
Best Practices	
Florida modeling standards are established through the FSUTMS. Standards are reviewed, researched and voted on by the voting members of the Florida Model Task Force, which is described in more detail below: Voting members of the task force consist of representatives from 27 regional planning organizations, Florida DOT districts, Florida's Turnpike Enterprise, and one representative from each of the following: Florida transit agencies, six FSUTMS users groups and FHWA.	

Florida Department of Transportation

Best Practices (continued)

In addition to these voting members, transportation professionals throughout the state participate in task force discussions and technical committee activities as nonvoting members.

The respondent also offered additional comments and recommendations for agencies developing travel forecasting guidance:

- Developing modeling standards for the state has many positive benefits, particularly for legal challenges, training and optimizing procurement initiatives for software, data and ancillary modeling tools.

Each agency's standards should consider the technical and financial differences across the state. For example, most of Florida's major urban areas use activity-based models. However, the cost and staff commitment to develop and maintain these models would strain the resources of many of the state's smaller MPOs. This concern was expressed at one of the agency's model task force meetings. Statewide, the agency has adopted a mix of trip- and activity-based models.

It is "highly important to have buy-in from all of your agency partners, as well as the private industry conducting business in the state."

Related Resources

FSUTMSOnline.net, Florida Department of Transportation, undated.
http://www.fsutmsonline.net/index.php
From the web site: FSUTMSOnline, maintained by the FDOT Forecasting and Trends Office, is a central hub for Florida travel demand modelers. This web portal provides news and information to Florida modelers and is a source for downloading model data files and documentation. To search the entire website by keyword, click on any menu item above. Join our mailing list to receive announcements about Model Task Force meetings, upcoming training course schedules, software updates, and other news.

FSUTMS-CBT, Version 1.0**,** Lehman Center for Transportation Research, Florida International University, 2019.
http://lctr.eng.fiu.edu/fsutmscbt.htm
This web site offers access to computer-based training for Florida DOT's Systems Planning Office and its workshop on the standard model used by Florida's urban areas for travel demand forecasting.

Project Traffic Forecasting, Florida Department of Transportation, 2019.
https://www.fdot.gov/planning/systems/programs/sm/ptf/default.shtm
This web site provides several resources associated with the agency's traffic forecasting practices and contact information.

Project Traffic Forecasting Handbook, Florida Department of Transportation, 2014.
https://www.fdot.gov/docs/default-source/content-docs/planning/systems/programs/sm/ptf/docs/PTF_Handbook_2014.PDF
From the acknowledgments:

> This document is a continuation of FDOT's effort to develop an improved traffic forecasting procedure. In order to determine the actual method in use throughout the Districts, and to standardize these methodologies, a statewide survey was conducted by interviewing engineers and planners who produce or use traffic forecasts. A task team was formed to draft a compilation and explanation of the standardized design traffic forecasting methodologies. The result is this Project Traffic Forecasting Handbook. It represents a consensus approach to traffic forecasting.

Chapter 3 (page 3-52 of the handbook, page 63 of the PDF) provides guidance "in the application of models to develop traffic projections for route-specific studies"; Chapter 4 (page 4-86 of the handbook, page 97 of the PDF) provides "a description of the appropriate methods of performing trend analysis and examination of local land use plans, and other indicators of future growth in the project traffic forecasting process."

Framework for Multi-Resolution Analyses of Advanced Traffic Management Strategies, Mohammed Hadi, Yan Xiao, Tao Wang, Somaye Fakharian Qom, Leila Azizi, Jianmin Jia, Aidin Massahi and Md Shahadat Iqbal, Florida Department of Transportation, November 2016.
http://www.fsutmsonline.net/images/uploads/reports/FDOT-BDV29-977-19-rpt.pdf
From the abstract: Demand forecasting models and simulation models have been developed, calibrated and used in isolation of each other. However, the advancement of transportation system technologies and strategies, the increase in the availability of data, and the uncertainty of traveler behavioral responses to new strategies have increased consideration of integrating different modeling tools. This project investigated the ability of combinations of tools to assess congestion impacts and advanced strategies that address such impacts. As a result, the project has developed a multi-resolution modeling framework for use in support of agency analyses and modeling of congestion impacts and advanced strategies. As examples, this project applies the multi-resolution modeling framework to (1) managed lanes with consideration of travel time reliability and heterogeneous traveler attitudes towards paying tolls, (2) work zones and associated diversion, and (3) active traffic management on arterial streets. The project investigated associated activities, including estimating origin-destination demand matrices using data from multiple sources such as automatic vehicle identification data and turning movement counts and assessing link-level variation of connected vehicle market penetration.

Texas Department of Transportation

Background

Texas DOT began conducting travel forecasting and modeling in the late 1950s/early 1960s. Updates to project-level guidance were issued in 2017; modeling updates were completed in 2018.

Texas Department of Transportation	
The Agency's Model	
Model Description	Federally funded modeling can produce trip-based and statewide results.
Model Application	• Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years. Agency management specifies that travel demand models are not used for project-level analysis. Models are used instead to inform the analysis, usually through growth rate and origin-destination patterns.
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	Project-level and modeling guidance is reviewed regularly and updated as needed.
Ensuring Relevance to Current Conditions	• Project-level analysis follows national and National Cooperative Highway Research Program (NCHRP) guidance, and is tailored to address Texas needs. • Projects use the latest planning data. • Historical projects are evaluated to see how well forecasts match open-to-traffic counts.
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	• Project-level forecasts are prepared for feasibility and planning, and provide 24-hour-volume annual average daily traffic forecasts that constitute a baseline. Scenarios, alternatives and operational analysis are adjusted from the baseline. • Travel demand models are developed to support long-range planning and constitute a baseline for metropolitan transportation plans, scenario analysis and alternatives analysis. • Urban models are daily (average weekday) models. • Statewide model supports time-of-day and freight analysis, and contains a weekend model.

Texas Department of Transportation	
Elements of the Agency's Travel Forecasting Guidance	
Policy- and Project-Level Questions	Congestion, connectivity, safety, performance measures, scenario analysis, feasibility, air and noise analysis, hot spot analysis and design/pavement analysis. The statewide model is also used to support the statewide, freight and rail plans, and to analyze freight/trucks, rail, ports and tolling.
Addressing Induced Vehicle Travel Demand	The agency's travel forecasting guidance does not address induced vehicle travel demand.
Relationship to Statutory Requirements	The agency's travel forecasting guidance does not address statutory requirements.
Best Practices	
The respondent reiterated the factors that ensure the relevance of forecasting practices to current conditions: Project-level analysis follows national and NCHRP guidance, and is tailored to address Texas needs. Projects use the latest planning data, and historical projects are evaluated to see how well forecasts match open-to-traffic counts.	

Related Resources

Traffic Data and Analysis Manual, Texas Department of Transportation, September 2001.
http://onlinemanuals.txdot.gov/txdotmanuals/tda/tda.pdf
See Chapter 2, Urban Travel Demand Forecasting, which begins on page 62 of the PDF, for a discussion of Texas DOT's modeling and forecasting tools and practices. This chapter addresses the agency's travel demand model package, travel demand modeling process and output, air quality conformity modeling, the organizations involved in travel demand modeling and travel demand modeling procedures.

Business Process and Logical Model to Support a Tour-Based Travel Demand, Jun Deng, Karen Lorenzini, Edgar Kraus, Rajesh Paleti, Marisol Castro and Chandra Bhat, Texas Department of Transportation, August 2013.
https://library.ctr.utexas.edu/ctr-publications/0-6759-1.pdf
From the abstract: Changing modeling needs over the past few years, spurred by the evolving policy contexts of transportation planning and emerging technologies, have led the planning community to explore tour-based and activity-based modeling paradigms as an alternative to the traditional trip-based modeling paradigm. As a leading travel model practitioner, the Texas Department of Transportation (TxDOT) Transportation Planning and Programming Division sponsored an earlier study to synthesize tour-based modeling approaches in the country and identify potential benefits and costs of transitioning to this emerging modeling paradigm in Texas. Based on the results of that study, the current research effort developed a business case for a tour-based travel demand model system. The business case discusses the justification and need for a tour-based model, and includes a business process model and a logical data model that provide the step-by-step actions and procedures needed to support the design and

development of a tour-based travel model. The business case not only justifies the need for tour-based models, but also proactively identifies potential challenges and constraints that may arise in implementation and provides pathways to address them. It also addresses the need to continue to operate trip-based models in parallel with tour-based where needed or required and assesses any impacts of tour-based modeling on the Technological Services Division of TxDOT. Although TxDOT has not yet transitioned towards a tour-based modeling approach, the current study can facilitate the model's implementation if TxDOT decides to move forward.

Related Resource:

> **0-6759: Developing a Business Process and Logical Model to Support a Tour-Based Travel Demand Model Design for TxDOT**, Project Summary, Texas Department of Transportation, undated.
> https://library.ctr.utexas.edu/ctr-publications/psr/0-6759-s.pdf
> This two-page project summary describes the critical elements of the research project cited above.

Virginia Department of Transportation

Background

The respondent estimates that Virginia DOT began conducting travel forecasting and modeling in the 1970s. The agency currently uses guidance documents in two topic areas:

- Travel demand modeling, last updated in 2014; future updates will be completed as needed.
- Traffic impact analysis, last updated in 2013 in accordance with regulations.

Virginia Department of Transportation	
The Agency's Model	
Model Description	Federally funded modeling can produce trip-based, regional and statewide results.
Model Application	• Provide future traffic data for capacity analysis. • Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years. • Develop impact assessments of the conversion of high-occupancy vehicle (HOV) to high-occupancy toll (HOT) lanes on the local freeway system in future years.
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	See ***Related Resources*** below for the most recent updates to agency guidance.

Virginia Department of Transportation	
The Agency's Model	
Ensuring Relevance to Current Conditions	The agency continually reviews professional publications, including NCHRP reports and Transportation Research Board (TRB) conference proceedings. Assistance is also provided by the Virginia Transportation Research Council, which specializes in basic and applied research to support Virginia DOT, its primary customer.
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	Travel forecasting is based on available information, including: • Traffic history (regression analysis). • Travel demand modeling. • Institute of Transportation Engineers (ITE) trip rates for proposed developments. See ***Related Resources*** below for more information.
Policy- and Project-Level Questions	Future traffic information is developed for environmental and development impact studies, interchange justification report/interchange modification report studies, modal split and HOV/HOT lanes.
Addressing Induced Vehicle Travel Demand	The agency's travel forecasting guidance does not address induced vehicle travel demand.
Relationship to Statutory Requirements	Statutory requirements associated with the agency's travel forecasting practices include the following: Chapter 527 of the 2006 Acts of Assembly added § 15.2-2222.1 to state law and directed the DOT to promulgate regulations to carry out the provisions of the statute. It now requires localities to submit comprehensive plans, plan amendments and traffic impact analyses on certain rezoning proposals that will substantially affect transportation on state highways to VDOT for review and comment.
Best Practices	
The respondent noted that Virginia DOT is currently developing an overall forecasting guidance document that is expected to be published later in 2019, perhaps by the end of May. The respondent recommended reviewing the agency's previously issued guidance, cited in ***Related Resources*** below, which will be referenced in the upcoming traffic forecasting guidance.	

Related Resources

Virginia Transportation Modeling and Accessibility Program, Virginia Department of Transportation, 2019.
http://www.virginiadot.org/projects/vtm/vtm.asp
From the web site:

> The Virginia Transportation Modeling program (VTM) was created in 2005 and includes all metropolitan and statewide travel demand modeling. VTM is open to the travel demand

modeling staff of all state agencies, planning district commissions and metropolitan planning organizations.

The web site also indicates that "there are currently 14 Travel Demand Models in Virginia. The models of Blacksburg, Charlottesville, Danville, Fredericksburg, Hampton Roads, Harrisonburg, Lynchburg, Richmond, Roanoke, Winchester, and Virginia Statewide Model are supported by VDOT. The Bristol and Kingsport models are supported by the Tennessee Department of Transportation and the model of Northern Virginia is supported by the Metropolitan Washington Council of Governments."

Traffic Impact Analysis Regulations, Virginia Department of Transportation, 2019.
http://www.vdot.virginia.gov/info/traffic_impact_analysis_regulations.asp
This web site provides information on traffic impact analysis regulations, including administrative guidelines, an alternative trip generation methodology for mixed use developments, and forms and checklists.

Related Resource:

Traffic Impact Analysis Regulations Administrative Guidelines, Transportation and Mobility Planning Division, Virginia Department of Transportation, April 2013.
http://www.virginiadot.org/projects/resources/chapter527/Administrative_Guidelines_TIA_Regs_7.2012.pdf
Administrative guidelines for traffic impact analysis begin on page 37 of the guidelines (page 42 of the PDF).

Travel Demand Modeling Policies and Procedures, Version 2.0, Transportation and Mobility Planning Division, Virginia Department of Transportation, June 2014.
http://www.virginiadot.org/projects/resources/vtm/VTM_Policy_Manual.pdf
From the introduction: This manual has been developed to provide guidance for public agencies in the Commonwealth of Virginia responsible for developing, validating, and applying travel demand models and their consultants. It is intended for readers who have a basic understanding of travel demand modeling concepts and procedures.

Traffic Operations and Safety Analysis Manual (TOSAM), Version 1.0, VDOT Governance Document, Virginia Department of Transportation, November 2015.
http://www.virginiadot.org/business/resources/TOSAM.pdf
From the introduction:

> … VDOT developed this manual, the Traffic Operations and Safety Analysis Manual (TOSAM), to provide direction to VDOT project managers in selecting the most appropriate traffic and safety analysis tool(s) during the project scoping phase; understanding the data requirements and standard assumptions related to each analysis tool; and producing consistent output from these tools for traffic operations and safety analyses.

Trip Generation, 10th Edition Formats, Institute of Transportation Engineers, undated.
Product description at https://www.ite.org/technical-resources/topics/trip-and-parking-generation/trip-generation-10th-edition-formats/
This web site describes the components of the most recent edition of the Trip Generation Manual, which includes Volumes 1 and 2 of the manual, the third edition of the Trip Generation Handbook and the ITETripGen web-based application (see the citation below for further information about the latter).

ITETripGen Web-Based App, Institute of Transportation Engineers, 2017.
Product description at https://itetripgen.org/index.html
From the web site: The *ITETripGen* Web-based App includes the entire trip generation dataset based on the *ITE Trip Generation Manual, 10th Edition*. This app offers functionalities such as querying and filtering data by:

- Site settings (e.g., rural, suburban, urban).
- Age of data.
- Region.
- Development size.
- Trip type (person or vehicle trips).

The app is only available as part of the *ITE Trip Generation Manual*, 10th Edition Bundles.

Atlanta Regional Commission (Georgia)

Background

Atlanta Regional Commission began conducting travel forecasting and modeling in the 1980s. Updates to the models and related guidance were completed in 2017.

Atlanta Regional Commission (Georgia)	
The Agency's Model	
Model Description	Modeling developed with the use of local, state and federal funds can produce activity-based and regional results.
Model Application	• Provide future traffic data for capacity analysis. • Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years . • Develop impact assessments of proposed projects (land use) on the existing freeway system in future years. • Develop impact assessments of the conversion of HOV to HOT lanes on the local freeway system in future years.
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	A thorough consultation process with major regional planning partners and stakeholders, local modelers and the state DOT is part of quarterly model users group meetings.
Ensuring Relevance to Current Conditions	• Oversee all modeling work that employs the travel demand model. • Closely coordinate and monitor all model applications. • Meet with all project sponsors and consultants requesting and applying the travel demand model.

Atlanta Regional Commission (Georgia)	
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	• Use of the "latest and greatest" planning assumptions. • Consistency with air quality conformity determinations. • Consistency with FHWA, Federal Transit Administration and U.S. Environmental Protection Agency guidance on travel forecasting. • Consistency with basic premises pertaining to model development, model applications, model calibration and validation. • Provide guidance for roadway and transit network coding.
Policy- and Project-Level Questions	• Project-level travel/traffic forecasts. • Policy scenario testing associated with TNCs and automated/connected vehicles. • All toll projects, including congestion pricing and managed lanes. • Transit investments and accompanying travel forecasts.
Addressing Induced Vehicle Travel Demand	Induced demand and induced travel are accounted for via the agency's fully integrated transport/land use modeling approach.
Relationship to Statutory Requirements	Project-level coding associated with socioeconomic data development requirements has an unspecified statutory basis.
Best Practices	
The commission regularly conducts model peer reviews and stays current with state-of-the-practice travel modeling and research conducted by TRB and NCHRP.	

Related Resources

Activity Based Modeling, Modeling, Atlanta Regional Commission, 2019.
https://atlantaregional.org/transportation-mobility/modeling/modeling/
This web site summarizes the commission's activity-based modeling activities and includes links to models, reports and a user guide. A frequently asked questions document is available at https://cdn.atlantaregional.org/wp-content/uploads/abm-frequently-asked-questions-2017.pdf.

Model Users Group (MUG), Atlanta Regional Commission, 2019.
https://atlantaregional.org/transportation-mobility/modeling/model-users-group-mug/
From the web site: The Atlanta Region's MUG serves as the forum for all users of the ARC Travel Demand Model. The goals are to educate, inform and improve travel demand forecasting as part of the regional transportation planning process. MUG membership consists of staff from local, regional and state agencies, in addition to members of academia and consulting.

"Integrated Model of Travel Demand and Network Simulation," Peter Vovsha, James E. Hicks, Matt Stratton, Robert Tung, Rebekah Anderson, Gregory Giaimo and Guy Rousseau, *Transportation Research Board 97th Annual Meeting*, Paper #18-05502, 2018.
Citation at https://trid.trb.org/view/1496801
From the abstract: The authors' paper describes a new approach to integrate an Activity-Based travel demand Model (ABM) and Dynamic Traffic Assignment (DTA) model, taking maximum advantage of the disaggregate nature of both models. This approach is referred to as "deep integration." With this approach, all interaction between the ABM and DTA is implemented at the individual level without an aggregation bias. Vehicle trips are generated by ABM for DTA and Level-of-Service (LOS) variables are determined by DTA for the ABM. The paper suggests solutions for several long-standing issues in ABM-DTA integration such as achieving logical consistency between activity durations and travel times at the individual level and using individual trajectories generated by DTA as a source of LOS for ABM. The developed ABM-DTA integration system includes two levels of equilibration: 1) external loop that includes a generation of a complete daily activity pattern, and 2) internal loop that includes equilibration of individual daily schedules, trip departure times, and route choices. The paper is based on project research for the Atlanta Regional Commission (ARC) and Ohio State DOT (ODOT) sponsored by the FHWA C10 grants. It describes the results of application of the developed integrated ABM-DTA system for real-size regional networks of Atlanta, GA and Columbus, OH.

Puget Sound Regional Council (Washington)

Background

Based in Seattle, the Puget Sound Regional Council "develops policies and coordinates decisions about regional growth, transportation and economic development planning within King, Pierce, Snohomish and Kitsap counties." The agency began conducting travel forecasting and modeling more than 30 years ago. Its activity-based model is updated regularly, along with related documentation.

The agency does not provide formal guidance to model users, though local agencies or consultants often will start with the agency's model and tailor it to their needs. Typically, this involves creating a subarea model that includes more network detail in the study area.

Puget Sound Regional Council (Washington)	
The Agency's Model	
Model Description	Modeling developed with the use of local, state and federal funds can produce trip- and activity-based and regional results.
Model Application	• Provide future traffic data for capacity analysis. • Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years. • Develop impact assessments of proposed projects (land use) on the existing freeway system in future years. • Develop impact assessments of the conversion of HOV to HOT lanes on the local freeway system in future years.

Puget Sound Regional Council (Washington)	
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	Typically, model updates coincide with the release of the agency's regional transportation plan. At that time, the agency updates its model to a new base year.
Ensuring Relevance to Current Conditions	The agency engages with stakeholders such as planners within the agency and modelers from the region, and "strives to be on the leading edge of the state of the practice."
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	Moving to a new base year and adding features that are needed to answer the question being asked of the model. For example, the agency is currently adding a TNC mode.
Policy- and Project-Level Questions	Road pricing, project scenarios, land use scenarios (e.g., transit-oriented development versus distributed growth) and transit scenarios.
Addressing Induced Vehicle Travel Demand	The agency always runs its demand model with feedback from the network via skims and does not use fixed trip tables. (A travel forecasting glossary developed by the University of California, Irvine's Institute of Transportation Studies describes "skimming a network" as "the process of systematically identifying network paths (typically) based on the minimization of travel time, distance or generalized cost. The resulting matrices of zone-to-zone impedances are called skims"; see https://www.its.uci.edu/~mcnally/tdf-glos.html#s.)
Relationship to Statutory Requirements	While the respondent indicated that statutory requirements were not associated with his agency's use of the model, other agencies using the council's tools are subject to such requirements.
Best Practices	
Peer reviews have generated recommendations for agency consideration. The respondent also noted that the agency is "constantly improving" the model. See the data blog cited in ***Related Resources*** for information about some of the agency's model-related activities.	

Related Resources

Activity-Based Travel Model: SoundCast, Puget Sound Regional Council, undated.
https://www.psrc.org/activity-based-travel-model-soundcast
The council's web site describes the uses of its travel model:

- Forecast transit line use and volumes on a road in one-hour time periods.
- Analyze how transit, walking and biking rates will be impacted by future changes in the transportation network and land use.

- Clarify how packages of transportation project[s] and future tolling could impact a variety of households in different ways throughout the region.
- Find good locations for electric car charging and bicycle share stations.
- Describe how the aging population will impact our transportation network.

Soundcast User's Guide, Puget Sound Regional Council, GitHub, Inc., 2019.
https://github.com/psrc/soundcast/wiki
This wiki "describes the basic theory and process to use Soundcast for travel modeling applications." Users can download code and user's guides, and review a wide range of information about the model.

From the wiki:

> Soundcast is an activity-based model system that represents the travel behavior of each individual and household throughout King, Kitsap, Pierce and Snohomish counties. The model depicts travel behaviors that depend on the built environment and demand from other users. Soundcast outputs transportation network measures such as highway volumes in one-hour periods in a future year, or number of boardings on a transit line. It also outputs measures related to people like average distance to work by home county or the number of transit trips different types of people will take.
>
> The three main components of Soundcast are:
>
> - Person trip demand in the DaySim activity-based model.
> - Submodels including external, truck and special trips (to unique locations like airports and military bases).
> - Trip assignment onto road networks.
> - Output preparation for analysis.

i/o: the psrc data blog, Puget Sound Regional Council, 2016.
http://psrc.github.io/
The INPUT/OUTPUT (I/O) blog from the technical data team of Puget Sound Regional Council offers current information about the agency's Soundcast travel model and other tools and software used by the agency.

"Using an Activity-Based Model to Explore the Potential Impacts of Automated Vehicles," Suzanne Childress, Brice Nichols, Billy Charlton and Stefan Coe, *Transportation Research Record 2493*, pages 99-106, 2015.
Citation at http://dx.doi.org/10.3141/2493-11
From the abstract: Automated vehicles (AVs) may enter the consumer market with various stages of automation in 10 years or even sooner. Meanwhile, regional planning agencies are envisioning plans for time horizons out to 2040 and beyond. To help decision makers understand the effect of AV technology on regional plans, modeling tools should anticipate its impact on transportation networks and traveler choices. This research uses the Seattle, Washington, region's activity-based travel model to test a range of travel behavior impacts from AV technology development. The existing model was not originally designed with AVs in mind, so some modifications to the model assumptions are described in areas of roadway capacity, user values of time, and parking costs. Larger structural model changes were not yet considered. Results of four scenario tests show that improvements in roadway capacity and in the quality of the driving trip may lead to large increases in vehicle miles traveled, while a shift to

per mile usage charges may counteract that trend. Travel models will need to have major improvements in the coming years, especially with regard to shared ride, taxi modes, and the effect of multitasking opportunities, to better anticipate the arrival of this technology.

California Agencies

Case studies for the two California MPOs responding to the survey—Fresno COG and SACOG—are presented below.

The California agencies responded to all questions posed to respondents from other states and two additional questions not posed to out-of-state respondents. The California-specific questions addressed the possible impact of travel forecasting guidance on local development-intergovernmental review (LD-IGR), a mandated statewide initiative. LD-IGR is an ongoing effort in California focused primarily on avoiding, eliminating or reducing to insignificance potential adverse impacts of local development on the transportation system.

The case studies below include agency responses to the two questions relating to LD-IGR. Neither California respondent described the integration of forecasting into the LD-IGR process, or the impact of travel forecasting on reducing VMT or project review for LD-IGR.

Fresno Council of Governments

Background

Fresno COG began conducting travel forecasting and modeling in 1986. Updates to this guidance were completed in 2017 for the second phase of the San Joaquin Valley Model Improvement Plan (VMIP).

Fresno Council of Governments	
The Agency's Model	
Model Description	Modeling developed with the use of local, state and federal funds can produce trip- and activity-based and regional results.
Model Application	• Provide future traffic data for capacity analysis. • Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years. • Develop impact assessments of proposed projects (land use) on the existing freeway system in future years.
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	In April 2010, the eight San Joaquin Valley MPOs were awarded $2.5 million to update each Valley MPO model to be more sensitive to smart growth to meet the requirements of SB 375. (The 18 MPOs in California are subject to SB 375 for Sustainable Communities Strategy (SCS) development as part of the statewide effort to reduce greenhouse gas (GHG) emissions.)

Fresno Council of Governments	
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance (continued)	The Valley modeling improvements were completed in 2012 and used in the development of the agency's SCS in compliance with SB 375. Completed in 2017, Phase 2 of the VMIP updated the model base year and streamlined land use data.
Ensuring Relevance to Current Conditions	The agency's model was developed to analyze proposed land uses, circulation systems and air quality. This model covers the entire Fresno County area and meets or exceeds all state and federal modeling requirements. The model "is constantly being updated to insure incorporation of the latest planning assumptions."
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	The VMIP model is a trip-based, four-step travel demand model. The agency is currently developing an activity-based model to better respond to increasing interest in the planning community in measuring impacts from compact and mixed-use development, active transportation, transit, pricing and other factors. Activity-based model validation and calibration are ongoing.
Policy- and Project-Level Questions	The agency's model played a key role in the following: • Developing the agency's long-term regional transportation plan (RTP). • Forecasting GHG emissions corresponding to various future land use scenarios. • Ensuring air quality conformity of transportation projects. • Assessing project-level traffic impacts for various local developments.
Addressing Induced Vehicle Travel Demand	The model addresses induced vehicular travel by providing iterations in model runs where increased roadway capacities will meet the travel demand and provide better level of service, therefore making the particular route more attractive in the trip assignment. In the subsequent iterations, the model will attempt to send more trips to this route in the process of achieving equilibrium.
Relationship to Statutory Requirements	Though not citing specific statutory references, the respondent cited modeling results that have been used in connection with the following: • California Environmental Quality Act analyses to assess traffic impacts. • The agency's RTP. • Multiple city and county general plan updates.

Fresno Council of Governments	
Best Practices	
The agency and model consultants work continuously on improving the model. The most recent example is the ongoing effort to develop an activity-based model.	
Local Development-Intergovernmental Review	
LD-IGR Integration into Forecasting	The respondent addressed both LD-IGR questions with the same response: The agency's modeling results, together with RTP/SCS scenario planning and land use forecast, were reviewed and commended through its RTP public review process.
Forecasting Impact on VMT	See above.

Related Resources

Final Fresno COG VMIP 2 Model Development Report, Fresno Council of Governments, November 2017.
https://www.fresnocog.org/wp-content/uploads/publications/Draft_Final_VMIP_2_Model_Development_Report_FresnoCOG_Nov2017_2.pdf
From the overview: This document provides guidance on the model specifications and data used in developing the components for the San Joaquin Valley Model Improvement Plan, Phase 2 (VMIP 2).

The objective of this document is to provide an overview and full technical details of the VMIP 2 models: this includes aspects common to all VMIP 2 models as well as specific calibration and model validation for the Fresno Council of Governments (Fresno COG) model. Changes between the original VMIP 1 models and the VMIP 2 models receive special emphasis.

Final VMIP 2 Model User Guide, Kern Council of Governments, April 2017.
http://www.kerncog.org/wp-content/uploads/2017/11/VMIP-2-Model-User-Guide.pdf
From the overview: This document is a general user guide for all San Joaquin Valley Model Improvement Program Phase 2 (VMIP 2) models due to their similar structure. The content of the guide covers installation, use and output review. Model development and validation reports were developed separately for each individual model and are available from the relevant MPO.

Sacramento Area Council of Governments

Background

SACOG began conducting travel forecasting and modeling in the 1980s. The respondent did not indicate when agency guidance was last updated.

Sacramento Area Council of Governments	
The Agency's Model	
Model Description	The agency maintains an activity-based regional travel demand model. Staff time is largely funded by federal Metropolitan Planning Funds (PL funds). Occasional grants are provided for specific forecasting or modeling projects; occasional participation in research efforts is funded by others.
Model Application	• Provide future traffic data for capacity analysis. • Provide future data for air quality analysis. • Conduct corridor analysis for design alternative assessments in future years. • Develop impact assessments of the conversion of HOV to HOT lanes on the local freeway system in future years. SACOG's application of its travel demand model is focused on region-level system analysis and, to a lesser extent, project phasing analysis. The agency provides its model to Caltrans and member agencies for use on their projects. SACOG is conducting its first modeling effort on HOT lanes and other price-managed facilities for the ongoing 2020 Metropolitan Transportation Plan/SCS update.
Updating the Model and Related Guidance	
Updating the Model and Forecasting Guidance	The agency relies on unspecified guidance provided by the California Transportation Commission and FHWA, and has not developed independent guidance. (See pages 37 and 38 for California Transportation Commission guidance documents.)
Ensuring Relevance to Current Conditions	See above.
Elements of the Agency's Travel Forecasting Guidance	
Key Concepts	See **Updating the Model and Related Guidance**.
Policy- and Project-Level Questions	Policy-level questions: • Land use/transportation connection and interactions. • Phasing of growth. • Trade-offs on roadway system expansion versus operations and maintenance investments.

Sacramento Area Council of Governments	
Elements of the Agency's Travel Forecasting Guidance	
Policy- and Project-Level Questions (continued)	Policy-level questions: (continued) • Reduction in vehicle emissions and achievement of air quality standards. • Reduction in carbon emissions from vehicles and the MPO's role in achieving the state's climate change goals. Project-level questions: • Phasing of transportation projects. • Project impacts now versus project impacts in the future. • Cost-effectiveness of transportation project investments.
Addressing Induced Vehicle Demand	The agency follows guidance provided by state and federal agencies.
Relationship to Statutory Requirements	Not applicable.
Best Practices	
While the agency develops documentation to support its modeling efforts and provides user training, SACOG has not developed independent guidance to supplement recommendations provided by other agencies.	
Local Development-Intergovernmental Review	
LD-IGR Integration into Forecasting	None.
Forecasting Impact on VMT	None.

Related Resources

SACOG Travel Demand Model, Sacramento Area Council of Governments, 2019.
https://www.sacog.org/modeling
This web site describes SACOG's travel demand model:

> SACOG's travel demand model, known as SACSIM, predicts how people in the six-county SACOG region travel on a typical weekday, including where they go, when they make trips, why they make trips, what travel mode or modes they use, and much more.

Sacramento Activity-Based Travel Simulation Model (SACSIM15), Draft Model Reference Report, Sacramento Area Council of Governments, September 2015.
https://www.sacog.org/sites/main/files/file-attachments/appendix_c-4_travel_model_documentation.pdf
From the introduction:

> This report provides a detailed description of SACSIM15, which was developed and used for evaluation of the draft Metropolitan Transportation Plan/Sustainable Community Strategy (MTP/SCS) update scheduled for adoption in February 2016. This report documents several key changes and improvements to SACSIM which were implemented since SACSIM11 was released. The report is also intended to serve as a reference document for external users of SACSIM. The report will remain as "draft" until all public comments on the draft MTP/SCS and DEIR [draft environmental impact report] are received and processed. A final version will be published after adoption of the MTP/SCS.

Though a draft, this 2015 publication appears on the agency's web site with the final documents for the 2016 MTP/SCS.

"SACOG's Regional Travel Demand Model Program," Workshop for Planners' Committee, Sacramento Area Council of Governments, March 2014.
https://www.sacog.org/sites/main/files/file-attachments/plnrscmte_sacog_travel_model_wkshp_27mar2014.pdf
This workshop presentation describes the agency's models and modeling program.

Related Research and Resources

The recent domestic publications described below are organized into two categories:

- National guidance.
- State guidance.

National Guidance

Traffic Analysis Tools, Federal Highway Administration, June 2018.
https://ops.fhwa.dot.gov/trafficanalysistools/index.htm
From the web site: The Traffic Analysis Tools Program was formulated by FHWA in an attempt to strike a balance between efforts to develop new, improved tools in support of traffic operations analysis and efforts to facilitate the deployment and use of existing tools. FHWA has established two tracks under the Traffic Analysis Tools Program: the deployment track and the development track.

The TMIP [Travel Model Improvement Program] Transportation Modeling and Analysis Toolbox, Federal Highway Administration, June 2018.
https://www.fhwa.dot.gov/planning/tmip/resources/toolbox/
This web site provides background information and links to a wealth of publications, webinars and other resources associated with transportation modeling in these topic areas:

- Exploratory modeling and simulation.
- Travel model development.
- Model validation and checking.
- Strategic and sketch modeling.
- Traditional and emerging data.
- Dynamic traffic assignment.
- Activity-based modeling.
- Land use modeling.

NCHRP Report 852: Method Selection for Travel Forecasting: User Guide, Maren Outwater, Kevin Hathaway, Kittelson & Associates, Inc., Oregon Systems Analytics LLC and Keith Lawton Consulting, Inc., 2017.
Publication available at https://www.nap.edu/catalog/24929/method-selection-for-travel-forecasting
From the foreword: *NCHRP Research Report 852* is designed for practitioners at state transportation agencies; metropolitan planning organizations (MPOs); transit agencies; and consultants who scope, develop and apply travel-forecasting models. It is coupled with and supports the method selection software tool, TFGuide.
….
Planning and policy questions addressed by the research cover a broad range of issues:

- Long-range planning.
- Performance-based planning.
- Safety.
- Project prioritization.
- Traffic impact study.
- Operational analyses.
- Transit analyses.
- Walk and bike activity forecasting.
- Freight planning.
- Environmental justice analyses.
- Economic impact analyses.
- Emergency management.

- Pricing study.
- Air quality and climate change analyses.
- Other planning issues that models are often asked to address.

Each of the planning and policy issues identified are coupled to a set of "information needs," such as (a) level of temporal and spatial flows by market segment, (b) volume and speed outputs, (c) mode of travel, (d) travel cost, (e) travel delay, and (f) other relevant performance metrics.

Related Resource:

> **Web-Only Document 234: Developing a Method Selection Tool for Travel Forecasting**, Maren Outwater, Kittelson & Associates, Inc., Oregon Systems Analytics LLC and Keith Lawton Consulting, Inc., 2017.
> Publication available at https://www.nap.edu/catalog/24931/developing-a-method-selection-tool-for-travel-forecasting
> This publication documents the research behind the development of the method selection process and the software tool developed and presented in NCHRP Report 852.

Purpose of Project-Level Travel Forecasting, *Travel Forecasting Resource (TFResource)*, National Academy of Sciences, 2016.
http://tfresource.org/Purpose_of_project-level_travel_forecasting
This topic page on a community-based web site overseen by TRB was developed in response to the 2007 publication, TRB Special Report 288, Metropolitan Travel Forecasting: Current Practice and Future Direction. The committee preparing TRB Special Report 288 recommended development of a national travel forecasting handbook. This TFResource was developed to "eventually be that handbook."

From the overview:

> The purpose of these guidelines is to describe both best practice and acceptable practice for performing project-level traffic forecasts for the state DOTs and similar agencies. The guidelines describe a number of techniques and options that are all acceptable within their intended scope, specific to the technique. Techniques include:
>
> - Custom travel forecasts using conventional three-step or four-step travel forecasting software;
> - Refinement of existing travel forecasts or of new forecasts from existing models; and
> - Statistical analysis of time series.

Activity-Based Travel Demand Models: A Primer, Joe Castiglione, Mark Bradley and John Gliebe, Second Strategic Highway Research Program (SHRP2), Transportation Research Board, 2015.
https://planningtools.transportation.org/files/108.pdf
From the foreword: This publication is a guide for practitioners that describes activity-based travel demand model concepts and the practical considerations associated with implementing them. Activity-based travel demand models portray how people plan and schedule their daily travel. This type of model more closely replicates actual traveler decisions than traditional travel demand models and thus may provide better forecasts of future travel patterns. The guide is composed of two parts. Part 1 is intended to help managers, planners and hands-on

practitioners and modelers make informed decisions about activity-based model development and application. Part 2 examines the practical issues that transportation agencies face in migrating from traditional to "advanced" travel demand models, in which activity-based models are linked with regional-scale dynamic network assignments.

NCHRP Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design, CDM Smith, Alan Horowitz, Tom Creasey, Ram Pendyala and Mei Chen, 2014.
Publication available at https://www.nap.edu/catalog/22366/analytical-travel-forecasting-approaches-for-project-level-planning-and-design
From the introduction: The project-level traffic forecasting guidelines presented herein are intended to

- Help standardize the traffic forecasting process for highway projects,
- Give practical guidance to practitioners,
- Give a high-level understanding to forecast users, and
- Help define the current state of traffic forecasting practice.

….
This report may be thought of as a revision of NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design [published December 1982]. A tool box of techniques for directly creating project-level forecasts or for post-processing travel demand model results for use in the planning and design of highway projects was originally published in NCHRP Report 255.

NCHRP Report 716: Travel Demand Forecasting: Parameters and Techniques, Cambridge Systematics, Inc., Vanasse Hangen Brustlin, Inc., Gallop Corporation, Chandra R. Bhat, Shapiro Transportation Consulting, LLC, Martin/Alexiou/Bryson, PLLC, 2012.
Publication available at https://www.nap.edu/catalog/14665/travel-demand-forecasting-parameters-and-techniques
From the foreword:

> This report is an update to NCHRP Report 365: Travel Estimation Techniques for Urban Planning [published in 1998] and provides guidelines on travel demand forecasting procedures and their application for solving common transportation problems. The report presents a range of approaches that allow users to determine the level of detail and sophistication in selecting modeling and analysis techniques most appropriate to their situations and addresses straightforward techniques, optional use of default parameters, and appropriate references to other more sophisticated techniques.

Portions of the report that may be of particular interest to Caltrans include:

- *Chapter 6, Emerging Modeling Practices* (page 89 of the report, page 98 of the PDF). This chapter introduces activity-based, dynamic traffic assignment and traffic simulation models, and describes how they work and how they differ from the conventional models discussed in the rest of the report.
- *Chapter 7, Case Studies* (page 100 of the report, page 109 of the PDF). The data provided in this report is expected to be used for two purposes:
    - Developing travel model components when no local data suitable for model estimation are available.
    - Checking the reasonableness of model components developed using local data.

The case studies presented in this chapter illustrate the use of the report for these purposes.

- *Appendix B, Review of Literature on Transferability Studies* (page B-1 of the report, page 133 of the PDF). This appendix includes a discussion of three primary topics: trip generation, trip distribution/destination choice and mode choice. A conclusions section is followed by a list of relevant references.

Dynamic Traffic Assignment: A Primer, Yi-Chang Chiu, Jon Bottom, Michael Mahut, Alex Paz, Ramachandran Balakrishna, Travis Waller and Jim Hicks, *Transportation Research E-Circular*, No. E-C153, June 2011.
https://onlinepubs.trb.org/onlinepubs/circulars/ec153.pdf
From the preface: Now, after decades of research and intensive market readiness developments, dynamic traffic assignment (DTA) models have become a viable modeling option. DTA models supplemental [*sic*] existing travel forecasting models and microscopic traffic simulation models. Travel forecasting models represent the static regional travel analysis capability, whereas microscopic traffic simulation models are superior for dynamic corridor-level travel analysis. DTA models fill in the gap by enabling dynamic traffic to be modeled at a range of scales from the corridor level to the regional with expanded and unique functional capabilities enabled by the DTA methodology.
….
The objectives of this primer therefore are to

- Explain the basic concepts of DTA and various DTA definitions and implementations,
- Highlight the types of transportation analysis applications for which DTA models could be found useful,
- Provide information about how to select a DTA model that best serves the intended application,
- Provide information regarding planning for and executing a DTA traffic analysis activity, and
- Describe the general DTA modeling procedure and modeling issues that may concern a model user.

NCHRP Synthesis 406: Advanced Practices in Travel Forecasting, Rick Donnelly, Greg D. Erhardt, Rolf Moeckel and William A. Davidson, 2010.
Publication available at https://www.nap.edu/catalog/22950/advanced-practices-in-travel-forecasting
From the preface:

> This study explores the use of travel modeling and forecasting tools that represent significant advances over the current state of practice. The study includes five types of models: activity-based demand, dynamic network, land use, freight and statewide.
>
> Information was gathered through literature review; detailed interviews among federal, state, and metropolitan agencies, and consulting firms; and case studies.

Lessons learned begin on page 53 of the report (page 62 of the PDF) and include discussions of the following topics:

- Assessing the case for advanced models.

- Value of a long-range modeling plan.
- Imperative of a champion.
- Advanced modeling requires more than modelers.
- Contracting and project management for success.
- Value of education is underappreciated.
- Debate over outsourcing versus homegrown remains unsolved.

Case studies of Sacramento and San Francisco begin on page 58 of the report (page 67 of the PDF).

Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA, Federal Highway Administration, March 2010.
https://www.environment.fhwa.dot.gov/nepa/Travel_LandUse/travel_landUse_rpt.pdf
From the executive summary:

> In light of the importance of forecasting, the high variation in practice, and the litigation risk involved, the Federal Highway Administration (FHWA) created this guidance to encourage improvement in how project-level forecasting is applied in the context of the NEPA [National Environmental Policy Act] process. While technical guidelines for producing forecasts for projects have been documented by others, little has been published on the procedural or process considerations in forecasting. This guidance attempts to fill that gap. The primary audiences are NEPA project managers, FHWA staff, forecasting groups at Metropolitan Planning Organizations (MPOs) and State Departments of Transportation (DOTs), as well as consultants that support MPOs and DOTs in conducting corridor and NEPA studies. Following this guidance is strictly voluntary.

This guidance document identifies and addresses seven key considerations:

- Assess project conditions and scope the forecasting needs of the study.
- Review the suitability of modeling methods, tools and underlying data.
- Conduct scoping and collaborate on methodologies.
- Objective application of forecasting in alternatives analysis.
- Project management considerations.
- Forecasting for noise and air emissions analyses.
- Documentation and archiving.

Evaluating and Communicating Model Results: Guidebook for Planners, Daniel Goldfarb, NCHRP Project 08-36, Task 89, AASHTO Standing Committee on Planning, June 2010.
http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36(89)_FR.pdf
From the introduction: The goal of this guidebook is to make the modeling process more understandable to planning practitioners in order to minimize the potential for misinterpretation, misrepresentation and misapplication of TDF [travel demand forecasting] models in the planning process.

Transportation planners should be able to 1) ask and answer critical questions about their agencies' models and model development processes; 2) understand how robust or sensitive the

outputs are, why that matters; and 3) incorporate that knowledge into planning and programming decision-making processes.

TRB Special Report 288: Metropolitan Travel Forecasting: Current Practice and Future Direction, Committee for Determination of the State of the Practice in Metropolitan Area Travel Forecasting, Transportation Research Board, 2007.
http://onlinepubs.trb.org/onlinepubs/sr/sr288.pdf
The report's summary findings and recommendations, which begin on page 1 of the report (page 15 of the PDF), describes what this special report was commissioned to address:

> The committee was tasked with assessing the state of the practice in travel demand forecasting and identifying shortcomings in travel forecasting models, obstacles to better practice, and actions needed to ensure the use of appropriate technical approaches. This report provides the requested assessment and recommendations for improvement and is designed for officials and policy makers who rely on the results of travel forecasting. A separate report commissioned by the committee is intended for readers with an interest in the technical details of current practice.

The report addresses the historical context of forecasting metropolitan travel; an institutional framework for travel demand modeling; the current state of the practice based on web surveys and MPO interviews; the shortcomings of current forecasting processes; and ways to advance the state of the practice.

State Guidance

Described below are manuals, guidelines and other publications that address travel modeling and forecasting practices in 11 states—Arkansas, California, Colorado, Georgia, Hawaii, Maryland, Minnesota, Nevada, Ohio, Oregon and Wisconsin. Additional guidance documents appear with the case studies presented previously in this report.

Arkansas

Traffic Handbook, Arkansas State Highway and Transportation Department, November 2013.
https://www.arkansashighways.com/System_Info_and_Research/traffic_info/documents/traffic_handbook_2014.pdf
This handbook provides instructions for traffic forecasting, turning movement count forecasting and equivalent single axle load (ESAL) forecasting. The handbook examines traffic data sources and factors, and describes agency practices for traffic forecasting with and without a travel demand model.

California

2017 Regional Transportation Plan Guidelines for Metropolitan Planning Organizations, California Transportation Commission, January 2017.
http://www.dot.ca.gov/hq/tpp/offices/orip/rtp/docs/2017RTPGuidelinesforMPOs.pdf
This publication is described as building upon the 2010 guidelines (cited in *Related Resource* below) and "reflects changes in federal and state law, current modeling information, and the experience gained with the application of travel demand modeling during the development of the first round of SCSs."

Chapter 3, RTP Analysis and Modeling, which begins on page 45 of the document (page 53 of the PDF), provides information about the policy-based and technical tools used to "assist in the

policy formation and decision-making process during the regional transportation planning process." The chapter also examines requirements for RTP analysis, which includes descriptions of model, travel demand model quality control and consistency, and planning practice examples. The chapter concludes with an examination of applicable state and federal laws.

Related Resource:

> **2010 California Regional Transportation Plan Guidelines**, California Transportation Commission, April 2010.
> http://www.dot.ca.gov/hq/tpp/offices/orip/rtp/index_files/2010%20RTPGuidelines_Jan2011_Technical_Change.pdf
> Chapter 3, Modeling, begins on page 33 of the document (page 41 of the PDF).

Colorado

Traffic Analysis and Forecasting Guidelines, Colorado Department of Transportation, July 2018.
https://www.codot.gov/library/traffic/traffic-manuals-and-guidelines/traffic_analysis_forecasting_guidelines/traffic_analysis_forecasting_guidelines
From the introduction:

> These guidelines aim to ensure consistent, state-of-the-practice traffic analysis and forecasting methods are used by all performing these functions. CDOT acknowledges that numerous Federal Highway Administration (FHWA) resources also have been published to guide analysts with traffic analysis and forecasting processes; therefore, these guidelines build upon those existing resources and customize the guidance specifically to the needs of CDOT and its stakeholders.

Chapter 5, Forecasting, which begins on page 57 of the document (page 67 of the PDF), includes a forecasting overview that addresses sketch planning and travel demand modeling and offers guidance on both practices. The chapter concludes with a discussion of forecasting documentation that was adapted from NCHRP Report 765 (see page 34 of this report) and Florida DOT's Project Traffic Forecasting Handbook (see page 15 of this report).

Georgia

Design Traffic Forecasting Manual, Georgia Department of Transportation, October 2018.
http://www.dot.ga.gov/PartnerSmart/DesignManuals/Planning/GDOT%20Design%20Traffic%20Forecasting%20Manual.pdf
From the introduction: Prior to 2016, GDOT's technical guidance on its design traffic forecasting process and its requirements was included in the Department's Design Policy Manual. This document is GDOT's first stand-alone guidance document related to design traffic forecasts. This guidance explains the overall analysis process, the roles and responsibilities of those engaged in design traffic forecasting, and the required deliverables and their formats to be produced by the transportation professionals responsible for these activities. This document also includes appendices and sample graphics to assist Office of Planning design traffic personnel, design traffic forecasting professionals and GDOT project managers in the traffic forecasting process.

Hawaii

Guidelines for Project-Level Traffic Forecasting for Hawaii Department of Transportation, Panos D. Prevedouros, Alan J. Horowitz, Lambros Mitropoulos, Alyx Yu, Liang Shi and Daniel Lee, Hawaii Department of Transportation, December 2015.
http://rosap.ntl.bts.gov/view/dot/31466/dot_31466_DS1.pdf
From the abstract:

> These guidelines describe both best practice and acceptable practice for performing project-level traffic forecasts for the State of Hawaii. The guidelines describe a number of techniques and options that are all acceptable within their intended scope, specific to the technique. Techniques include (1) Custom travel forecasts using conventional three-step or four-step travel forecasting software; (2) Refinement of existing travel forecasts or of new forecasts from existing models; and (3) Statistical analysis of time series. To the extent possible these guidelines are consistent with national standards including the "Analytical Travel Forecasting Approaches for Project Level Planning and Design," NCHRP Report 765, which is an update of NCHRP Report 255.
>
> Four extensive case studies were developed with HDOT data, case study 1 based on the Lahaina Bypass, case study 2 based on the Saddle Road/West Side Defense Access Road (Daniel K. Inouye Highway), case study 3 which is a trends analysis on major highways, and case study 4 on models correlating ADT [average daily traffic] with other trends.

The following chapters may be of particular interest:

- *Chapter 2, Time Series Methods* (begins on page 10 of the document, page 24 of the PDF), describes methods that relate to "building linear statistical models of the amount of traffic on a highway segment. The models vary by how the independent variable(s) are defined with respect to the needs of the analysis and data availability."
- *Chapter 3, Evaluation* (begins on page 32 of the document, page 46 of the PDF), includes an examination of measures of effectiveness (MOEs), which are described as "direct outputs of travel models to gauge the amount of travel for an alternative and to understand the alternative's impacts." Among the MOEs reviewed in this chapter are VMT and vehicle hours traveled.

Maryland

Data Driven Transportation Decisions: Maryland Statewide Transportation Model, Maryland State Highway Administration, Maryland Department of Transportation, undated.
https://www.roads.maryland.gov/index.aspx?PageId=254
This agency web site describes a multitiered modeling methodology:

- *Level I: Travel demand models (or models at the regional scale)*. Maryland State Highway Administration (SHA) developed a statewide model, Maryland Statewide Transportation Model, a multilayer travel demand model working at national, statewide and urban zone levels to forecast and analyze key measures of transportation system performance.
- *Level II: Dynamic traffic assignment and mesoscopic models*. The web site notes that MDOT SHA is "still currently evaluating best practices and will incorporate mesoscopic modeling in the planning process once a systematic and data driven methodology has been established."

- *Level III: Microsimulation models*. These models "generate every single vehicle on the facility of interest, usually for a single intersection or for a very specific corridor. The models analyze and predict traffic patterns." Maryland SHA "currently uses VISSIM and Synchro on a frequent basis, but welcomes analysis from all software as long as calibration documentation is provided."

Related Resource:

VISSIM Modeling Guidance, Maryland Department of Transportation, August 2017.
https://www.roads.maryland.gov/OPPEN/VISSIM%20Modeling%20Guidance%209-12-2017.pdf
From the purpose: The purpose of the document is to outline best practice modeling techniques of a typical transportation operational analysis using VISSIM microsimulation modeling software and to provide guidance on specific details of VISSIM modeling for the Maryland Department of Transportation State Highway Administration (MDOT SHA), Travel Forecasting and Analysis Division (TFAD).

Minnesota

Traffic Forecasting and Analysis, Minnesota Department of Transportation, undated.
http://www.dot.state.mn.us/traffic/data/index.html
This web site provides links to documents describing the data and methods associated with volumes, vehicle classifications, weight, forecasting and VMT.

Mn/DOT Procedure Manual for Forecasting Traffic on Minnesota's Highway Systems, Traffic Forecasts and Analysis Section, Minnesota Department of Transportation, May 2012.
http://www.dot.state.mn.us/traffic/data/reports/forecast/Forecast_Manual_2012.pdf
This procedure manual begins with flow charts that illustrate traffic forecasting, the analysis procedure associated with calculating ESALs and trend analysis. An overview of these processes is followed by a step-by-step description of the forecasting process. Forecasting tips and techniques are supplemented by a wide range of examples. The manual also contains background information and terminology "to aid the forecaster in doing a complete and thorough job."

Nevada

Traffic Forecasting Guidelines, Nevada Department of Transportation, August 2012.
https://www.nevadadot.com/home/showdocument?id=4506
From the introduction: The purpose of these Guidelines is to document the Nevada Department of Transportation's (NDOT) techniques and accepted procedures for forecasting travel demand on NDOT maintained roadways within the State of Nevada (State).
….
In all, the Guidelines identify the traffic parameters necessary for accurate traffic forecasting across various types of transportation projects. The Guidelines also offer direction for producing traffic forecasts for planning projects, environmental analyses/studies, design projects and operational studies/projects. Also presented is the method on how to use the outputs from travel demand models to produce traffic forecasts and how to implement historical trend projection analysis techniques for producing traffic forecasts when a travel demand model is not available for the project location.

Ohio

Note: The Certified Traffic page of Ohio DOT's Modeling and Forecasting web site (see http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Pages/CertifiedTraffic.aspx) indicates that the agency's June 2007 publication, *Ohio Certified Traffic Manual*, is being replaced with the three draft volumes and appendices cited below. (A comment period ended December 31, 2018.) The agency's web site also indicates that a training course to accompany the release of the manuals is nearly complete.

Volume 1: Traffic Forecasting Background, Ohio Traffic Forecasting Manual, Ohio Department of Transportation, August 2018.
http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/180420%20Volume%201%20-%20Traffic%20Forecasting%20Background%20%5bDRAFT%20FINAL%5d.pdf
From the abstract: Volume 1 covers the basic information needed to obtain and interpret the results of a traffic forecast.

Volume 2: Traffic Forecasting Methodologies, Ohio Traffic Forecasting Manual, Ohio Department of Transportation, August 2018.
http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/180420%20Volume%202%20-%20Forecast%20Methodologies%20%5bDRAFT%20FINAL%5d.pdf
From the abstract: Volume 2 focuses on the forecast concepts and step-by-step instructions on how to develop and document traffic forecasts.

Volume 3: Travel Demand Modeling, Ohio Traffic Forecasting Manual, Ohio Department of Transportation, November 2018.
http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/181019%20Volume%203%20-%20Travel%20Demand%20Modeling%20%5bFINAL%5d.pdf
From the abstract: Volume 3 details the checks and adjustments made to Travel Demand Forecasting (TDF) models to produce various types of preliminary forecasts.

Appendices, Ohio Traffic Forecasting Manual, Ohio Department of Transportation, multiple dates.
http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/180420%20Appendices%20-%20Ohio%20Traffic%20Forecasting%20Manual.pdf
Included in the appendices are the following:

- Appendix A: Traffic Count Guidelines.
- Appendix B: MPO Map.
- Appendix C: MPO Modeling Contacts.
- Appendix D: Non-Interstate Bridge Replacement Form.
- Appendix E: Early Coordination Meeting Checklist.
- Appendix F: Certified Traffic Request Form.
- Appendix G: Draft Standard Scope.

Related Resource:

> **Ohio Certified Traffic Manual**, Office of Technical Services, Ohio Department of Transportation, June 2007.
> http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/OH_Cert_Traffic_Manual.pdf
> This is the manual that will be replaced by the three-volume *Ohio Traffic Forecasting Manual* cited on the previous page.

Guidelines for Planning Level Traffic and the Use of Models for Project Traffic Forecasting, Ohio Department of Transportation, October 2013.
http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/GuidelinesUseModels%20ProjectTraffic%20Forecasting_V5.pdf
From the introduction: The following guidelines are divided into two major sections; the first deals with definitions and processes and is intended for both modelers and project managers who need to obtain traffic forecasts for their projects. The second contains detailed project level model usage guidelines for modelers.

Oregon

Analysis Procedures Manual, Version 2, Transportation Planning Analysis Unit, Oregon Department of Transportation, November 2018.
https://www.oregon.gov/ODOT/Planning/Documents/APMv2.pdf
Sections of this manual that may be of particular interest to Caltrans include:

- *Chapter 6, Future Year Forecasting* (begins on page 6-1 of the manual, page 313 of the PDF).
- *Section 7.5, Travel Demand Models (Trip-based)* (begins on page 7-35 of the manual, page 443 of the PDF).
- *Section 8.5, Dynamic Traffic Assignment (DTA)* (begins on page 8-35 of the manual, page 494 of the PDF).

Wisconsin

Chapter 9: Traffic Forecasting, Travel Demand Models and Planning Data, Transportation Planning Manual, Wisconsin Department of Transportation, May 2018.
https://wisconsindot.gov/Documents/projects/data-plan/plan-res/tpm/9.pdf
From the introduction and purpose:

> Chapter 9, Traffic Forecasting, Travel Demand Models and other Planning Data outlines WisDOT's forecasting process, from input assumptions to final output results. This chapter formalizes and standardizes the process, requirements and background information used to do traffic forecasting and multimodal travel projections in Wisconsin. It is also a reference for all parties who use traffic forecasts and travel demand estimation techniques in the corridor planning and project development processes.
>
> As noted in National Cooperative Highway Research Program Report # 765 Analytical Travel Forecasting Approaches for Project-Level Planning and Design, forecasting guidelines are intended to standardize, guide and give a high-level understanding of techniques. The guidelines are used for the planning, design and operation of highway system elements.

The chapter addresses the following topic areas:

- General forecasting protocols and procedures.
- Forecasting in travel demand model areas.
- Wisconsin travel demand models.
- Traffic Analysis Forecasting Information System (TAFIS).
- Data elements of roadway traffic forecasting.
- Traffic impact analysis.
- Travel surveys.

Contacts

CTC contacted the individuals below to gather information for this investigation.

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Florida

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Appendix A: Survey Questions

The following survey sought information about transportation agency experience with travel forecasting from two groups of potential respondents:

- *Other state agencies*. Eight state departments of transportation and four metropolitan planning organizations (MPOs) expected to have experience with travel forecasting.
- *California agencies*. Six MPOs and a regional transportation planning agency that are representative of agencies serving large urban areas and the more rural areas of California.

The same questions were posed to both groups of respondents, with the exception of two questions addressing a mandated ongoing statewide effort in California and its possible relationship with agency travel forecasting practices. These questions were presented to only the California agency respondents and are identified below.

Travel Forecasting Background

1. When did your agency begin to conduct travel forecasting and modeling?
2. When did your agency complete its last formal update of travel forecasting guidance?
3. Please describe your agency's process for updating its travel forecasting guidance.
4. Please describe the key concepts that constitute the basis of your agency's travel forecasting guidance.
5. Please describe how your agency ensures that its travel forecasting guidance remains relevant to current conditions.
6. What are the transportation policy-level questions, and the transportation project-level questions, that your agency's travel forecasting and modeling staff are asked or required to address?

Travel Forecasting Elements

1. Please describe your agency's travel demand model by selecting all that apply.
    - Trip-based model.
    - Activity-based model.
    - Statewide model.
    - Regional model.
2. What is the funding source for model development and update?
    - Federal funds.
    - State funds.
    - Local funds.
    - Combination of above.
    - Other (please describe).

3. Please describe how your agency uses its travel demand model at the project level by selecting all that apply.
    - To provide future traffic data for capacity analysis.
    - To provide future data for air quality analysis.
    - To conduct corridor analysis for design alternative assessments in future years.
    - To develop impact assessments of proposed projects (land use) on the existing freeway system in future years.
    - To develop impact assessments of the conversion of high-occupancy vehicle (HOV) to high-occupancy toll (HOT) lanes on the local freeway system in future years.
    - Other (please describe).
4. Does your agency's travel forecasting guidance address induced vehicle travel demand? If yes, please describe how this is addressed.
5. Are there specific elements/sections of your agency's travel forecasting guidance that address statutory requirements for evaluation of development-related or project-related impacts? If yes, please cite the statutory requirement and describe how these elements are applied.
6. How are standards of practice or best practices incorporated into your agency's travel forecasting guidance?

Note: The two questions below were provided to only the California respondents.

Local Development-Intergovernmental Review

Local development-intergovernmental review (LD-IGR) is a mandated ongoing statewide effort in California that is focused primarily on avoiding, eliminating or reducing to insignificance potential adverse impacts of local development on the transportation system.

1. Does your agency integrate scenario planning and/or forecasting into the LD-IGR process? If yes, please describe your agency's practices.
2. Has your agency found that its travel forecasting guidance or policies have been helpful in a reduction of vehicle miles traveled and project review for the LD-IGR process? If yes, please describe your agency's practices.

Wrap-Up

1. Do you have documentation related to your agency's travel forecasting guidance and practices that you can share? Please provide links to electronic files and send any files not available online to chris.kline@ctcandassociates.com.
2. Please use this space to provide any comments or additional information about your previous responses.